THE

ENGINEERING MAGAZINE

VOL. XIV. DECEMBER, 1897. No. 3.

NATIONAL DIFFERENCES IN LABOR-HANDLING METHODS.

By Hiram S. Maxim.

THE Turkish metal-worker is able to produce some very remarkable results, as far as appearance is concerned, with the simplest of appliances. The primitive Turkish lathe is an exceedingly simple affair, but it requires a great deal more skill to execute a good piece of work on one of these lathes than to work any of the high-class tools that one finds in western Europe or America. A Turkish pistol may be of a highly ornate character, and, to the casual observer, may appear an excellent piece of work, but it will not bear close examination, as there is nothing approaching accuracy about it, and, of course, no two pistols are alike in any of their measurements. The Turk may be said to represent the extreme eastern system, where great skill in manipulation and very few tools are employed, and where everything goes for show and nothing for accuracy, while the Americans may be considered to represent the extreme west, where the tools are of the very highest character, and the skill necessary to operate them (not to make them) may be easily and quickly acquired. Nothing is sacrificed in an American pistol for ornamentation, but the accuracy of the work is something remarkable, and all pistols of the same class are exactly alike, and all their parts are interchangeable. All of the work on a Turkish pistol has to be executed by an old and experienced mechanician ; great skill in manipulation and taste in execution are a *sine qua non ;* but the elegant and accurate work that one finds in American pistols is executed for the most part by unskilled workers. The skill—or, as one may say, the brains—is in the accurate tools, or, rather, in the men who design and make them, and not in the simple operatives who attend to them.

Copyright, 1897, by John R. Dunlap.

In Turkey the workshops are extremely small and the purchasers few, but in the United States, the population being very large and the demand for metal work very great, enormously large factories have grown up to meet the demand. It is because the country is large that it pays the manufacturer to put down a large plant and produce on a large scale. As already stated, the Turk represents the old, or extreme eastern, idea of Europe, while the American represents the new, or western, system, and Europe may be said to occupy intermediate grades. In the United States one may reckon on a very large demand for a standard article, and it pays the manufacturer to provide special tools and instruments for testing and measuring the work with a degree of nicety never attempted in Europe. Manufacture in the United States is specialised. One firm may confine itself to producing revolvers, and another to the production of sporting magazine rifles, while others make a specialty of lathe chucks, others of twist drills, others of high-speed engines of a certain type, others of gun-making machinery, etc. But in England one firm often undertakes a great variety of work. The consequence is that none of the factories are so well fitted for any special work as those of the United States.

Travelling eastward, we find smaller shops, fewer tools, and greater skill in manipulation. As in the United States it is a question of tools and a large production, so in the east of Europe it may be said to be a question of skill and small production. The English traveller invariably expresses surprise on entering a large American factory. He is not prepared for the cleanliness and order that prevail, while the American, in visiting many English shops, is simply amazed at the rusty and battered tools, and the dirt, disorder, and general sloth that are apparent. This, of course, is not true of the increasing number of thoroughly modern English shops.

When I first came to London, I wished to obtain a few tools, and, visiting a shop where they were sold, I was surprised at their rough and antiquated character. Upon asking them for something better, —something more like American tools,—the reply was: "Oh, these are real English tools, made in England, and everybody knows that English tools are the very best in the world." This was about fifteen years ago. No matter where I went, everyone was of the opinion that the only recommendation that a tool required was that it was made in England,—that it was real English, and genuine English make—none of your cheap and nasty German or American things.

When I desired to purchase some American hickory wheels to be used on light gun-carriages, the dealer refused to deliver them to me without tires. Upon asking why, he explained that formerly they had sold wheels without tires to anybody that came for them, but, as the

carriage-smiths' and the wheel-makers' societies were closely affiliated, the smiths were provided with fine saws, with which they sawed off the tenons on the spokes before they set the tires. This gave American wheels a black eye for some years, until the trick was discovered.

It is, however, only in England that one finds an ignorant prejudice against American productions. In Germany, France, Austria, and Russia everyone is ready to admit that the Americans are ahead, and the Germans were, I think, the first to take advantage of the situation. In the United States it costs a large sum of money to design and perfect any particular machine, and very great care is always exercised before the machine is finally put upon the market. The English, as a rule, honestly believe themselves to be ahead of every other nation in every branch of manufacture, and it is only in recent years that a few of them have stumbled upon the truth that some really good things come from America. But, as a rule, they do not make blind copies of American work. They wish always to have a finger in the pie themselves.

A short time ago an American cable line was established in Brixton, a suburb of London. Upon first visiting Brixton, I failed completely to recognise the system, as each car was provided with a small and extremely ugly locomotive. Upon closer inspection, however, I found that the locomotive carried simply the clamping device. Upon asking the "driver," or the man at the clamp, the object of the apparatus, he said:

"Oh, this is the locomotive. This draws the car."

"Oh," I said, "how nice! Please explain it."

"Well, underground here is a wire rope; this ere thing goes down through this ere slot, and clamps the rope, and the rope pulls the locomotive, and the locomotive pulls the carriage, don't you see?"

"What is the object of the locomotive?"

"Why, to draw the car, of course."

"But why not put the clamp on the car, and dispense with the locomotive altogether?"

After he had thought the matter over a short time, I asked again:

"What is the use of the locomotive?"

His reply was: "I'll be hanged if I know."

Now, if this system had been introduced into a country like Germany, France, or Spain, the natives would have had sufficient respect and confidence in American engineers and systems to have put it up in the exact manner that it was imported; but, as the English engineers were used to a locomotive and wished to make some change in the American model, they added the "locomotive," which certainly looks very awkward, and is, without question, superfluous.

On the continent a different state of affairs exists and always has existed. There the highest opinion of things American prevails.

When the German government commenced to make rifles on the interchangeable plan, they imported a large quantity of gun-making tools from the United States, manufactured for the most part by Pratt & Whitney. The superiority of these tools was at once apparent. The result is that the Germans at the present moment are making machine tools of the American type in vast quantities, but, vast as the production is, the demand is still greater, and to-day the great firm of Ludw. Loewe & Co. has four times as many orders as it is able to fill, and is now putting up extensive works at a cost of £500,000. It was only a few years ago that anyone equipping a machine shop in Europe obtained the greater part of his metal-working machinery from England, but to-day the obsolete, awkward, and comparatively high-priced English tools have been completely driven out of the market by the German-made American tools. Not only have the Germans secured this market, but they are also sending their tools in large quantities to England. It is true, however, that these German tools are not quite up to American standards. The iron is not quite so good, and the accuracy is less. Nevertheless they are very much superior to the ordinary English tools, and Germany to-day is the most serious competitor that England has. This may not be very agreeable reading for Englishmen, but there is nothing to be gained by suppressing facts.

The German metal-workers, for the greater part, are sober and reliable; they work very steadily from eleven to twelve hours a day, and are satisfied with wages considerably less than those which prevail in England.

The French have also taken advantage of American systems. A great many imitations of American tools are made in France, and many of them are up to the American standard.

While the United States and England employ a great number of horizontal milling machines using cutters with coarse teeth, which may be ground, the French use vertical milling machines as far as possible, and cutters with very fine teeth, which, as a rule, are never ground. They, however, have a very perfect apparatus for the rapid and cheap production of milling cutters of great accuracy. In France it is no uncommon thing to see a man running four planers, four lathes, or perhaps six milling machines. In fact, one man will often take charge of a whole roomful of machinery. Women are also employed, and run as many machines as they can attend to. There is absolutely no attempt at restricting the output of machines.

Many of the best French shops do not employ the same kind of

lathe on ordinary work that they employ for tool-making. They have a special tool-maker's lathe, which, in its way, is a very remarkable machine, costing about £100 and provided with a great number of attachments. As a whole, the French tools are equal to any made in Europe, and in many of them a considerable degree of originality is displayed.

In Austria and Switzerland tools of the American type are coming into use, while nearly all the steam engines are constructed on the American Corliss system.

In Russia one finds the manufactures of all countries. A large dealer told me that formerly nearly everything came from England, "but," he said, "at the present time all the rough and coarse tools we make ourselves. Moderately good tools come from Germany; very fine instruments of precision, such as squares, scales, micrometers, lathe chucks, twist drills, etc., from America."

"But," I said, "do you not get anything from England?"

"Oh, yes: Stubb's files, Stubb's wire, and engraving tools."

An English expert, who has recently visited American factories, writes as follows:

> In the American shops, whatever work may be required, a special machine is made for the purpose, in order to turn out the work in the most expeditious and cheapest manner possible. With their system they obtain a machine and use it for one class of work continually, and the shops in general are more complete than ours, with up-to-date tools.
>
> In the English shops, the manufacture of any one article is not sufficient to induce the manufacturer to use special machines for special work. In the English shops the generality of work is of a very varied nature, and the manufacturer who makes planing machines will also manufacture lathes, shaping machines, drilling machines, and various other tools, whereas in the American shops the manufacturers there apply themselves specially to the manufacture of one article as a specialty, and make it to the best of their ability for all it is worth. Until recently the English manufacturers have been working in the old methods of years gone by, with the same old tools which their forefathers used, but, owing to the competition brought about by improved American machinery coming into this market, they are now getting fresh methods and improving the shops very considerably. Unless the English manufacturers wake up to the fact that they should manufacture machinery of a better class and by improved methods, American tools will be coming into this market to an almost greater extent than heretofore.
>
> . . . . . .
>
> The tools are better cared for on the other side, and the workmen there seem to take a greater pride in doing work to the best of their ability. It seems the object of the workman to become the most skilled mechanic that he can possibly be, whereas on this side a man is perfectly content in continuing in the same groove that he has been in for years past.

An American tool maker, who has traveled extensively in Europe and whose name is exceedingly well-known as a manufacturer of the very highest order of machinery, on being asked what he considered

the true difference between English and American machine shops, wrote to me as follows:

It is time England was waking up, for her machine-tool business is going away from her very fast. Germany and America (and even France in some respects) are getting ahead of her in a great majority of metal manufactures. The great obstacle that is in the way of success in her case is the *trade-unions*. So far we have been able to run our own business in our own way, this side, but in England the trade-unions have gone so far as to dictate to the manufacturer as to the number of apprentices he shall take, the amount of work a man shall do; in the latter case they dictate the size of chip the man shall take, and allow him to run but one machine. They even have, in some cases, insisted upon dictating who the superintendent should be. The result is, in most cases, less than one-half the work per man is done; in some cases, with our labour-saving machinery, even up to twenty times the work is done by an unskilled man whose wages are not more than England pays for a skilled workman. England, and nearly all European countries, to save themselves, are importing large quantities of American machinery and tools. The writer was asked to consider the matter of purchasing a plant in England for making a certain kind of machine, but experience has demonstrated that such work could be made for a less cost here and exported to England, for the reasons given above.

You understand, no doubt, what another great factor is which enables our manufacturers in metals to compete successfully with the world After we are satisfied that an article is saleable, we proceed to make a model and give it a trial. Sometimes several are made before a satisfactory test is produced. After it has proved satisfactory, we proceed to make special tools and machines to manufacture it with, and it is made by unskilled labor to some extent and at a cost much less than could be done in the old manner, and a better quality of work, and each part interchangeable.

From the above, as well as from my own experience, it will be seen that the English manufacturer has many things to contend with which are almost unknown in the United States. In fact, it may be said that the greatest bugbear in England, the labour question, is practically non-existent among the manufacturers of high class metal work in the eastern part of the United States. I do not believe that one per cent. of the highly-skilled mechanics in the great workshops of New England belong to any sort of a trade union. Trade unionism there, if it exists at all, is confined to the unskilled labourers, such as hod-carriers, navvies, dock labourers, stevedores, etc., while in England trade unionism pervades every class of labour, skilled and unskilled. The American manufacturer, in taking a contract, can depend upon his men. Before taking a contract, it is not an exception—in fact, I may say, it is the rule—to call around him a considerable number of his best mechanics. The drawings are examined, the manner of making the work, the tools that will be necessary, the probable cost, etc., are discussed; then the master decides on the price at which the contract may be taken.

The American workman commences work at seven o'clock in the morning, and every man is at his bench or his lathe promptly on the stroke of the bell. He works steadily until twelve o'clock; he then

takes an hour for his dinner, and recommences work at one, continuing until six. On Saturday he works six hours, commencing at seven and leaving off at one.

In England it is supposed to be sufficient for the workman to pass the gate at six. He then dawdles along, spending from five to ten minutes in getting to his work. At eight o'clock he knocks off for half an hour for breakfast, and then works till one, when he has an hour for his dinner. He is supposed to commence work again at two o'clock, and to leave off at five, making nine and one-half hours a day and five and one half hours on Saturday—fifty-three hours per week. At the present moment, however, the workmen are striking for a forty-eight-hour week with fifty-three-hour pay.

The pay of the American metal-worker is about one-third more per hour than that of the English. Nevertheless a great variety of the better class of metal work can be produced in the United States at a considerably lower price than in England. It was not long ago that the Americans purchased steel in England, took it to the United States, paid 40 per cent. duty, made it into twist drills and fine tools, and sold them in England at a price considerably less than the cost of production in England.*

The labour question in England never reaches finality. Suppose, for the sake of argument, that the employers should grant a forty-eight-hour week with fifty-three-hour pay. There is not a single argument employed by the labour agitators to prove that an eight-hour day is preferable to a nine-hour day that could not be used with equal force to prove that seven hours is better than eight. Tranquility and contentment among the working-people is the state of affairs that the labour agitator does not like. He lives upon trouble and turmoil. If no actual grievance exists, he manufactures one so as to give at least some excuse for the support that he receives from his union.

It has always been the policy of the Engineers' Society to attack manufacturers singly, and then, when one has been subdued, to attack another. In the meantime, those who were at work supported those who were out on strike. But, now that the Employers' Federation has been formed, better things may be expected. Something of this kind was absolutely necessary, not only for the protection of the employer, but also for protecting the men themselves from their own folly. It is very evident that, if the engineering trade is to be kept in England, it is necessary that the employer should have the full and unhampered services of his employees, and the only way to accomplish this is to weaken the power of the professional agitator.

* This is true now, with the important exception that very many Americans make their own steel and therefore do not have to import it.

SHIP-BUILDING AS A PRODUCTIVE INDUSTRY IN GREAT BRITAIN.

By James McKechnie.

I. THE ECONOMIC RELATIONS OF ITS ENORMOUS GROWTH.

NO more profitable subject of contemplation for the ship-builder is conceivable than the full significance of Britain's maritime industries, especially in view of the progress of other countries. True, he has little time for such study: enough perhaps is provided for every-day occupation by the insatiable demands of the ship-owner for another fraction of a knot, or fifty tons more of deadweight capacity than had an immediately preceding ship, without additional cost. And yet the economic difficulties with which the manager of any industrial concern is beset, owing to the artfulness of the trade-union leader, forces one to give heed to the wider practical questions associated with manufacturers. It was doubtless this consideration which prompted the editorial appeal to me to enter into an analysis of the recognised importance of the marine industries to Great Britain, of the methods of maintaining the supremacy enjoyed, and of the significance of the efforts of other nations to secure some part, if not a great part, of the trade monopolized.

The time is not inopportune, and the subject has fascinations for the ship-builder, in which term I include for convenience the marine engineer. To some it may involve an issue too vital, but, as a rule, the very frequency of those labour troubles which underlie the whole question of the migration of industries and the prophecies of national disaster has engendered more or less of philosophic calm. Each hair-breadth escape deepens the hunter's love for adventure, while at the same time quickening his wits. And thus the ship-builder, while he does not court trouble, meets it nevertheless with peaceful reflection rather than with unreasoning panic. I do not take the view that self-interest is inoperative: but it must be recognized by all who care to see below the surface that the profit realisable is so meagre that many find themselves asking the question whether the game is worth the candle.

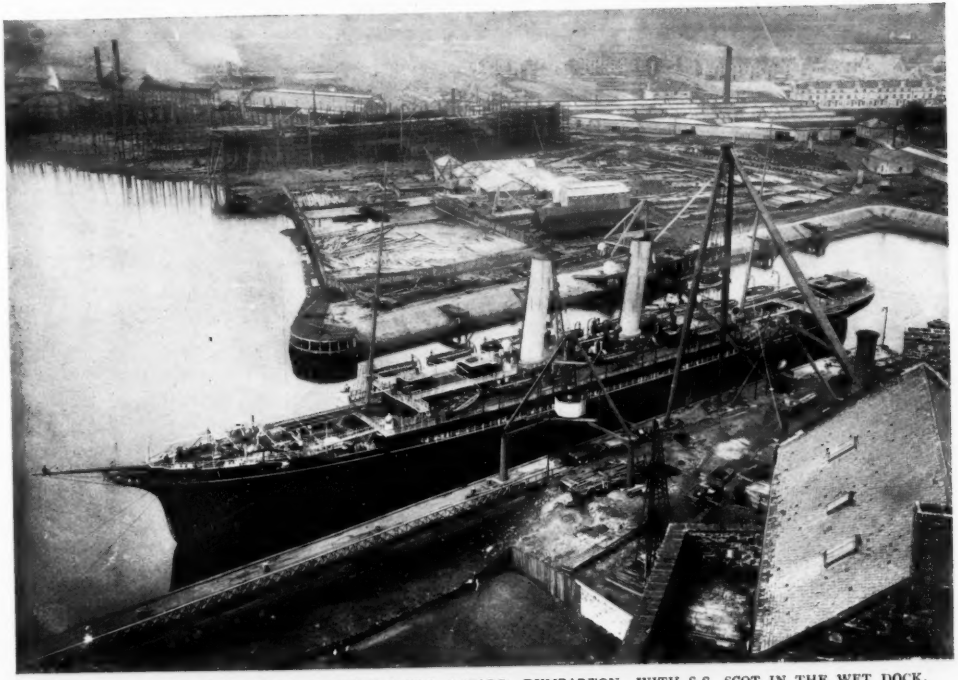
Let me take first the consideration which will appeal most readily to the average reader—the significance of the industry to the labouring class. It is certainly the most direct result because the first realised; any lessening in the demand for new shipping means at once idleness for the artizan. By a careful computation, which, although it might

THE SHIPYARD AND ENGINE WORKS OF THE CLYDEBANK ENGINEERING & SHIPBUILDING CO., LTD.

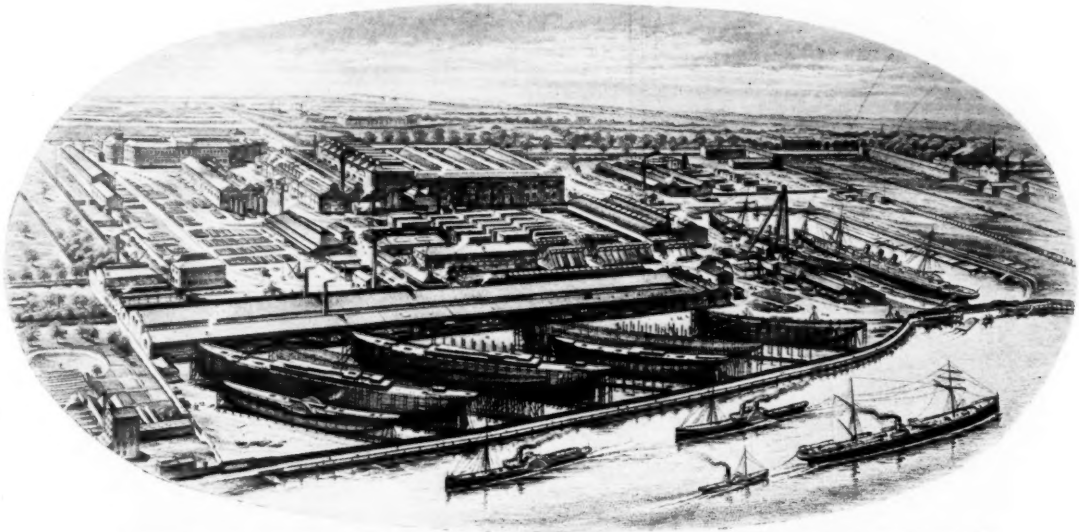
shock our old taskmaster, Euclid, is nevertheless sufficiently accurate for our purpose, I find that in an average year the ship-builders, including marine engineers of course, distribute in wages between eleven and twelve millions sterling. The cost of labour on an ordinary type of cargo steamer is about 34 per cent. of the total value of the vessel; on passenger steamers, with their superbly fitted and decorated saloon, the ratio is much higher; on marine engines the labour-cost ranges from 30 to 40 per cent. It is easy, then, to arrive at the labour-value of a given production. I have included the work done in the royal dock-yards, where, owing to the admirable system of accounting, it is easy to ascertain the amount distributed for labour, now about two million sterling per annum; but the total value of work now done in private yards for British and foreign navies exceeds as a rule by quite 50 per cent. that completed in the royal establishments. But this does not by any means exhaust labour's share in a year's ship-building.

Vessels aggregating 1,200,000 tons gross register—about the yearly average from all yards in Britain—require much steel, and this metal is not delivered in the building yard without a considerable labour-charge. It is interesting to note the labour-cost of winning the coal for each successive stage, of mining the iron ore, of melting it into pig iron, and finally of making the finished metal and rolling it into the angles and bars and plates which go to complete the anatomy of a modern ship. In few of these processes has it been found possible to supersede manual labour to the extent that it has been superseded in other branches of industry, and yet the price has been greatly reduced, although the rate of wages has not been lessened. Pig iron is a typical case. In 1877 the selling price was fifty-five shillings; to-day, by increasing the size of the blast furnace and introducing mechanical appliances in connection with charging, it has been possible to reduce it to forty-five. This suggestion of labour's inviolable right to equal, if not higher, remuneration, while the value of the finished product is reduced, is, however, by the way.

It is possible to arrive at a very close approximation of the labour-cost of a ton of steel. The depth at which the minerals are found, the metallic quality of the ore, and the quantity required to make the finished product, necessarily affect the result; but I take normal or medium cases. About fifty-five per cent. of the price of coal goes to labour in some form or other, and of that of iron ore about sixty per cent.; softer ores are perhaps more cheaply mined, but generally a larger quantity must be used in the blast furnace. It may be taken that, on an average, two tons of coal, and two and one-quarter tons of ore or ironstone, are needed for each ton of pig iron.



BIRD'S-EYE VIEW OF MESSRS. W. DENNY & BRO. S YARD, DUMBARTON, WITH S.S. SCOT IN THE WET DOCK.



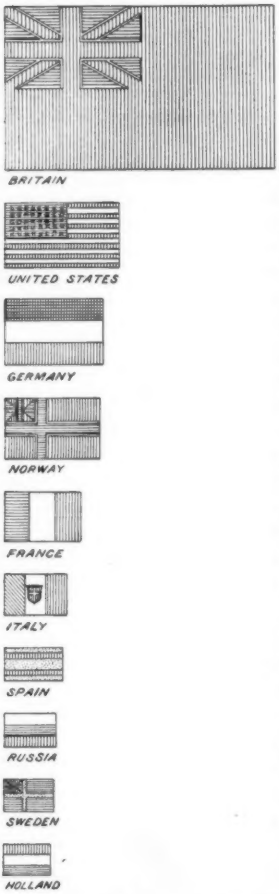
THE WORKS OF THE FAIRFIELD SHIPBUILDING & ENGINEERING COMPANY, LIMITED, GOVAN, GLASGOW, IN 1891.

The conversion process alone involves a labour-cost equal to a fourth of the ordinary selling-price of the pig iron. This raw material and one or two other ingredients, whose cost of production need not be analysed, go forward to the steel furnace, where fifteen per cent. of the ultimate selling-price of the steel is directly absorbed by labour. If these various contributions to labour be summed up, it will be found that almost exactly one-half—rather more than less—of the price of the finished steel goes to labour.

If, then, the labour involved in the production of the steel used in the ships built in a year be taken into consideration, the eleven or twelve millions sterling disbursed by the ship-builder amounts to about sixteen millions sterling, and in this is not included the contribution made, in name of transit, to the wages bill of the railway or steamship companies, or the cost of the many other materials used in building. I have made allowance also for the increasing amount of iron ore imported, the labour-cost of which is not disbursed in Britain. Last year Britain imported about five and one-half million tons, of which four and three-quarter million tons came from Spain. Yet, without the ship-building industry, our blast furnace-men and steel makers would not have the privilege of converting this into pure metal.

The influence of ship-building on England's shipping supremacy is a further important item on the credit side of the ledger. Her insular position would have made that shipping a necessity in any case, and her large deposits of metalliferous ore and coal ensured the establishment sooner or later of a merchant fleet of her own, and therefore of a naval force also. But it must be admitted that the initiative came from the marine constructor, and at the appropriate moment for the expansion of industries and of empire. The United States at the beginning of the century, with their wooden-built clippers, appeared to hold an unassailable position, and retained it long after iron ships were introduced. But, as soon as the system of compound engines was perfected and the coal consumption was reduced from 7 to 3 and even 2¾ pounds per h. p. per hour, the American clippers were beaten, if not in average speed, certainly in economy. That was Britain's flood tide; her mineral wealth enabled her to take it. Prestige was soon earned by the skill of the ship-builder and engineer, although few will deny England's debt to France, perhaps also to America, for some lessons and examples in the form of ships. The period of conflict and of bloodshed on the continent assisted, while the civil war in the United States set back the hands of the clock there.

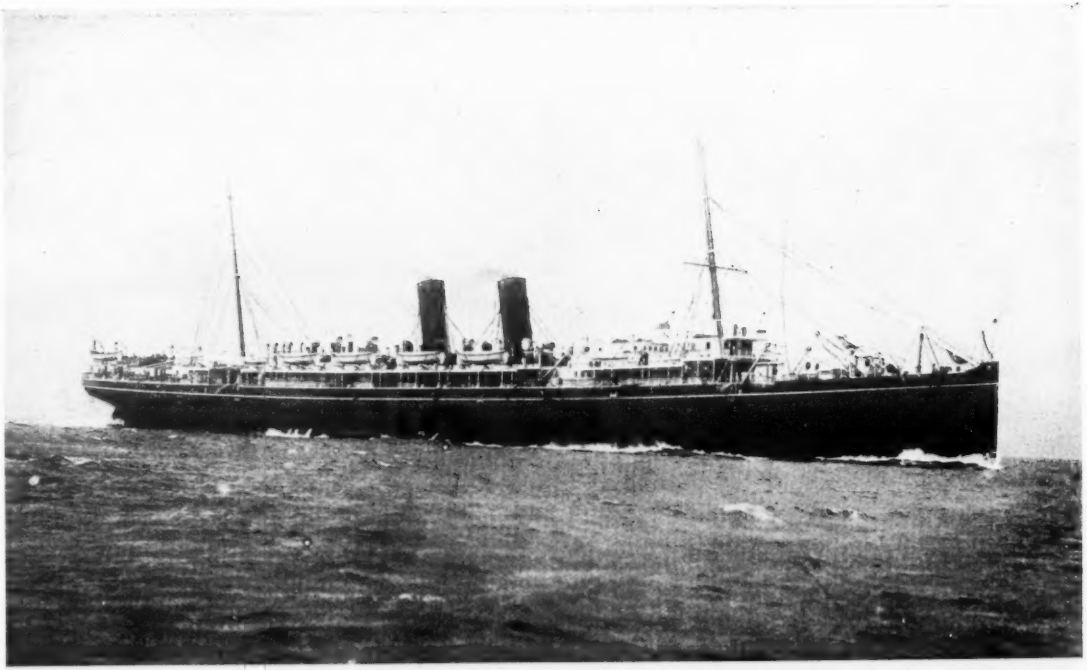
I am not concerned for the moment with the future, and its certain and vigorous contest by the awakened countries; it is enough



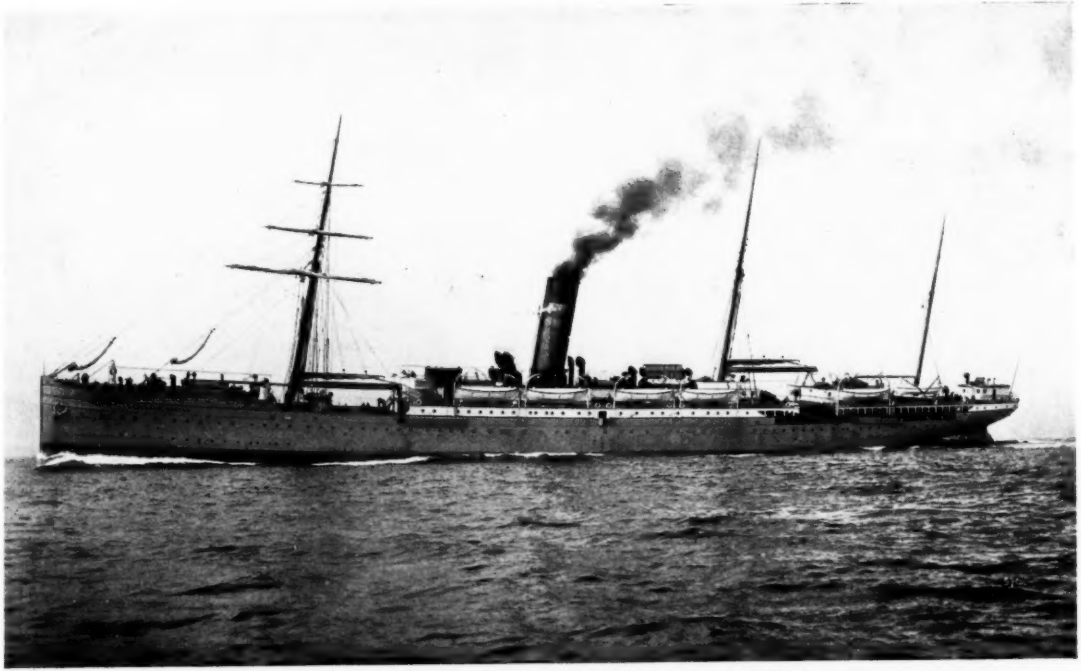
FLAGS ARRANGED ACCORDING TO MERCHANT TONNAGE OWNED BY PRINCIPAL NATIONS.

here to suggest that, having got the start, having established a great fame, it will be the more difficult, although by no means impossible as some think, to dislodge Great Britain. Evidence of her supremacy in maritime affairs is easily established. Her merchant fleet, according to Lloyds' almost infallible record, is nearly 13,250,000 tons, and, although the average size is 600 tons, there are many vessels of more than 6,000 tons. Psychological considerations—love of adventure, tendency to a nomadic life, etc.—partly explain this great floating population and wealth; but there can be no question of the encouragement offered to early British ship-owners by the low cost of ship-building, and, once established, the advantage was gained. The series of flags reproduced on this page conveys an idea of the relative proportions of the fleets of various nations, according to Lloyds. For every 100 tons of ships possessed by Britain the United States have only 16.6 tons, Germany has 14.6, Norway 12.5, France 8.45, Italy 5.85, Spain 5.28, Russia 3.9, Sweden 3.66, and Holland 3.33; other countries need not be indicated. It is worth stating, further, that Britain owns more than one-half of the sea-going merchant ships in the world. This preponderance could be maintained through all these years only by the influence of superior and economical ship-building, none the less robust because developed without artificial aid.

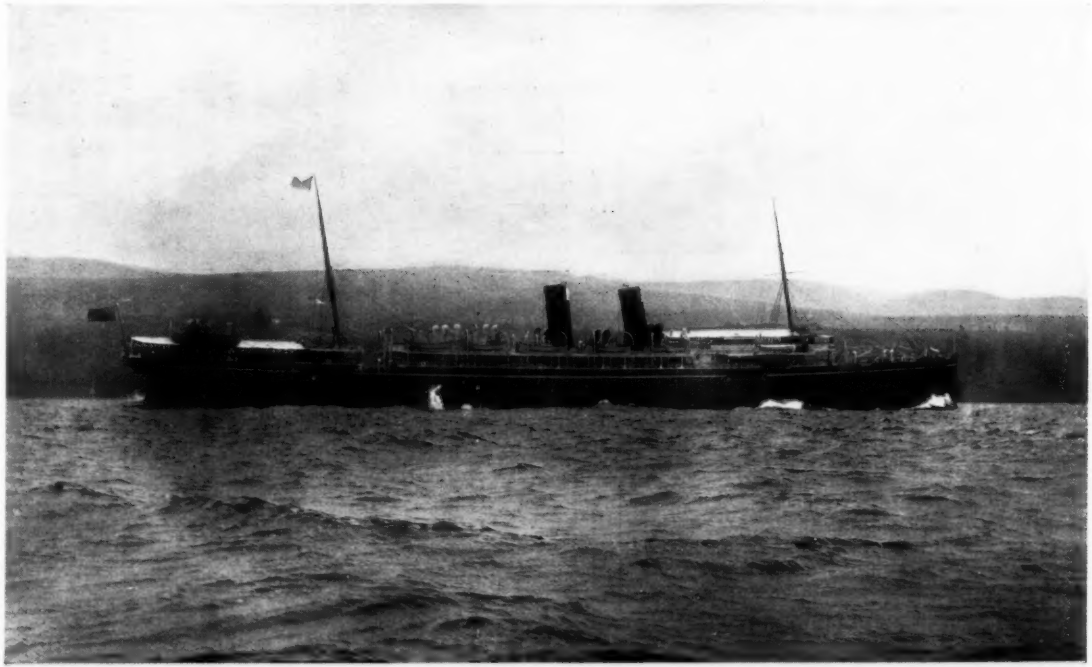
The work done by these vessels is a great source of national wealth. Thus the freightage on nearly three-fifths of the world's commerce is money-gain to Britain. A diagrammatic representation of this is interesting. The tonnage of vessels entering and clearing the ports of several nations is shown on page 382 by a series of squares,



PENINSULAR AND ORIENTAL S.S. COMPANY'S ROYAL MAIL S.S. INDIA.
Built by Caird & Co., Ltd., Greenock.



ROYAL MAIL S.S. DUNVEGAN CASTLE, OF THE CASTLE MAIL PACKETS CO., LTD.
Built by the Fairfield Shipbuilding & Engineering Co., Ltd.



S.S. TALISMAN.
Built by A. & J. Inglis, Pointhouse Shipyard, Glasgow.
By permission of J. Adamson & Son, Rothesay.

and within each is shown the proportion of British tonnage, and that of native tonnage, the remainder being that of other nations. The data are taken from the latest Board of Trade returns. Thus, the square for the United States shows that the tonnage frequenting her ports is nearly 33,750,000 tons, excluding the lake ships. Of this she provides 3,680,588 tons, while Britain supplies 17,500,000 tons, or 52.3 per cent. Even if the lake tonnage were included, America's proportion of her own trade would be only 23 per cent. In each square the black part represents Britain's share, the shaded part the share of the country in question, and the white part that of other countries. While much of the merchandise represented by the black section is foreign merchandise, there is strong reason for the saying

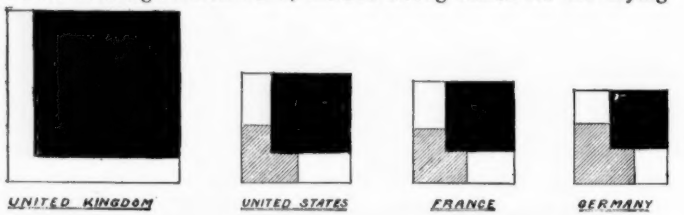
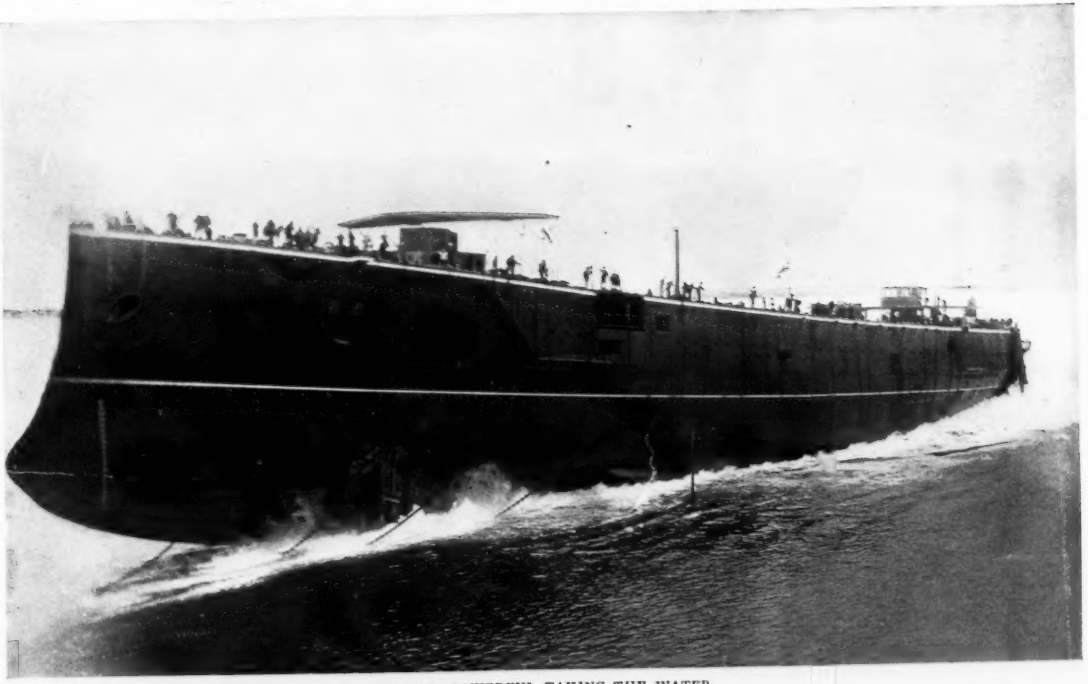


DIAGRAM SHOWING THE TONNAGE ENTERING THE HARBOURS OF VARIOUS NATIONS.

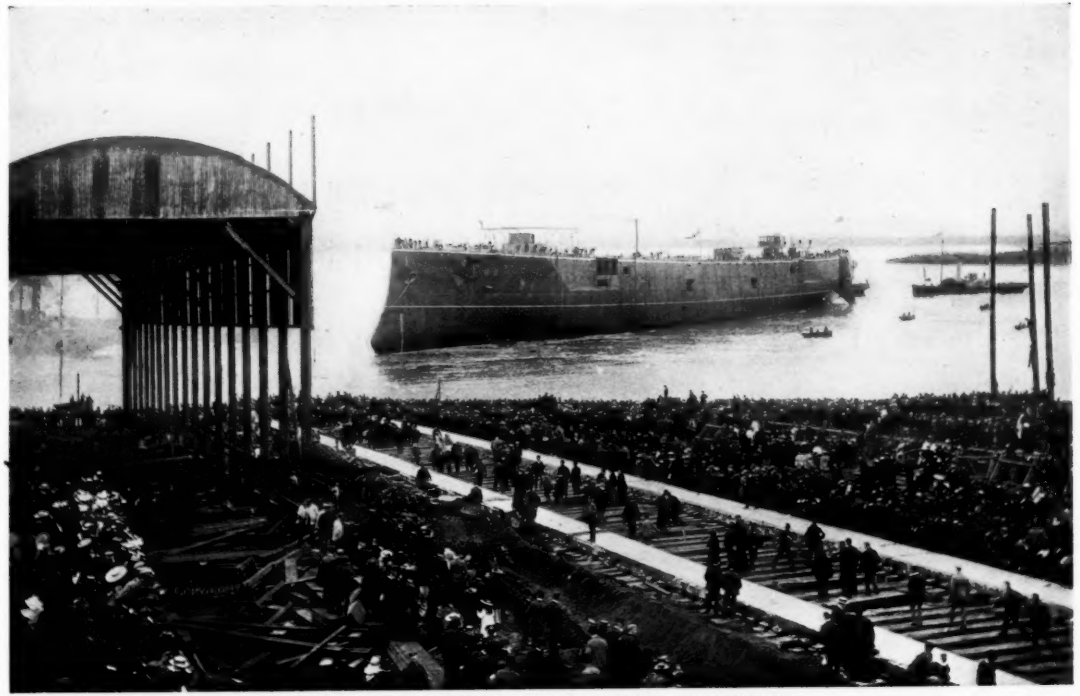
The black area in each indicates British tonnage, the shaded area, tonnage owned in the country, and the white part the tonnage of other nations. Thus, in the United States square, black is British, shaded American, and white foreign.

that trade follows the flag. These British ships are splendid advertisers of her commerce, as well as of her ship-building, while at the same time earning wealth in freightage. Again, it is the possession of this fleet, as well as the influence of the Bank of England, which makes Britain the great exchange emporium of the world. Seventy million pounds' worth of goods are so transhipped per annum; twenty years ago the value was only forty millions. The diagrammatic representation shows that 47 per cent. of the shipping frequenting French ports is British-owned, notwithstanding shipping bounties to French ships. Of the German over-sea-carrying 38 per cent. is done by vessels carrying the Union Jack, meaning 13,333,000 tons of British ships in German ports in a year. In Russia the proportion is 54 per cent.: in Holland 50.9 per cent.: and in several other countries about half. Sweden and Norway are the most nearly self-supporting, 80.4



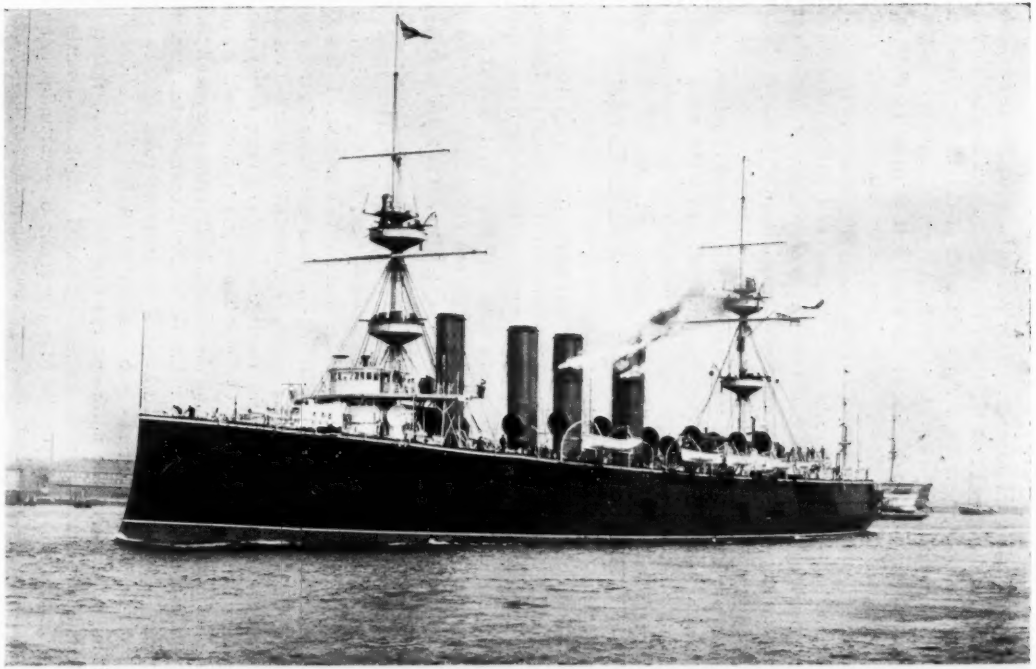
H.M.S. POWERFUL TAKING THE WATER.

Copyright by Arthur Hollis, Barrow-in-Furness.



H.M.S. POWERFUL SAFELY AFLOAT; SHOWING THE SHIPWAYS.

Copyright by Arthur Hollis, Barrow-in-Furness.

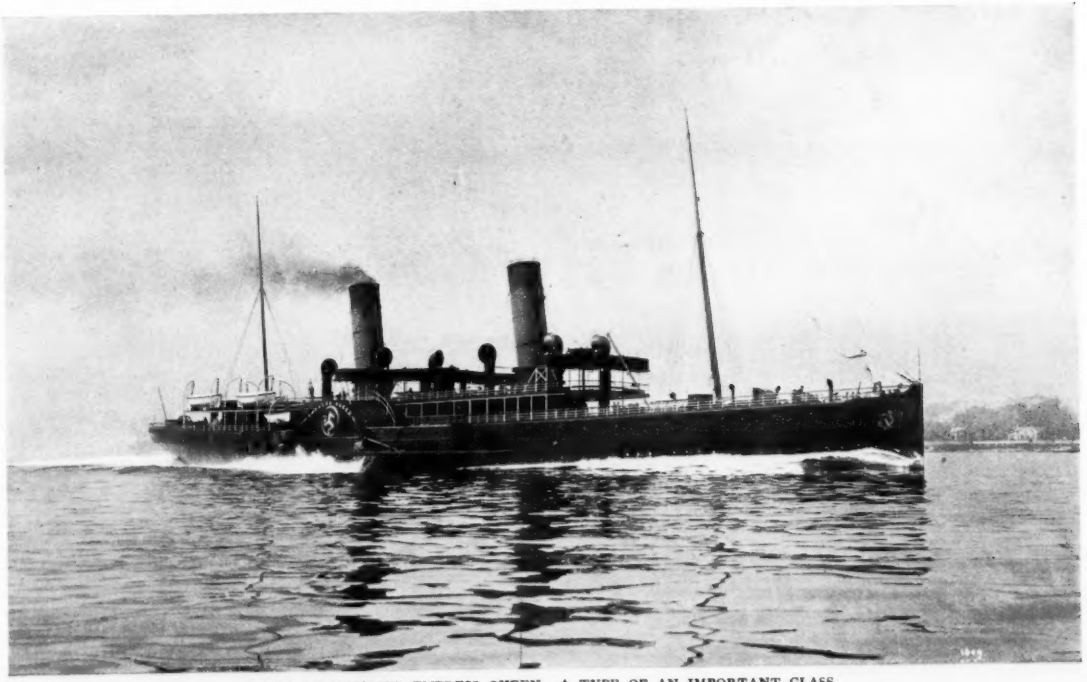


H.M.S. POWERFUL, SISTER SHIP TO THE TERRIBLE. 500 X 71 FT., 14,200 TONS, 25,000 H.P.
Built by Vickers, Sons & Co., Ltd., Naval Construction Works, Barrow-in-Furness.
By permission of Stephen Cribb, Southsea.

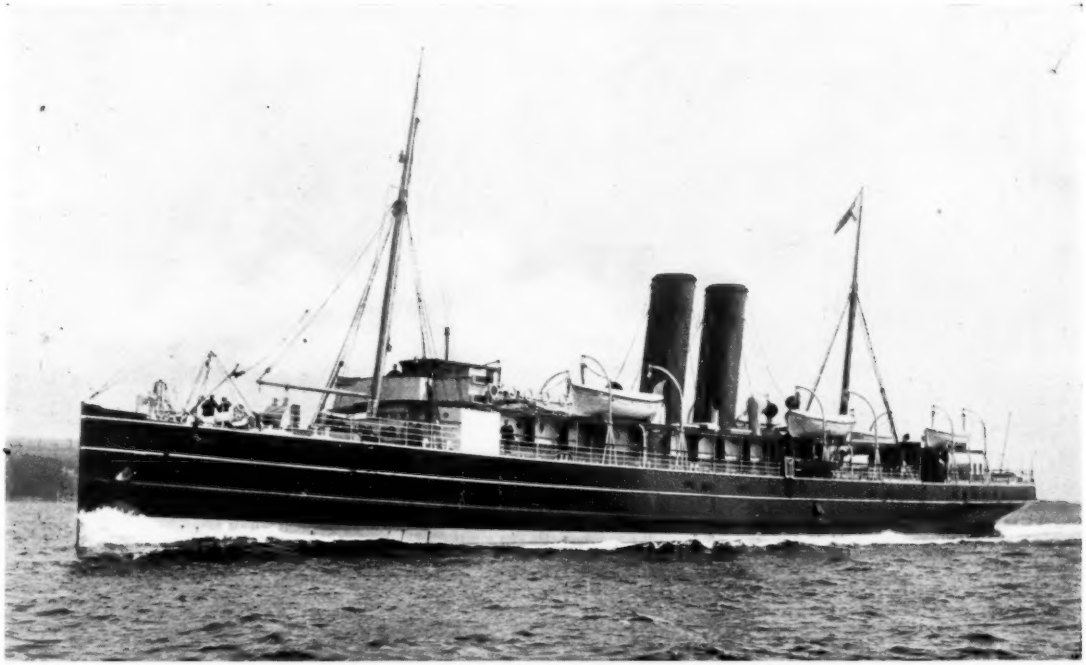
and 86 per cent. of the ships being of their own nationality. Truly, the old viking is still to the fore, but until recent years was content to buy Britain's old tonnage. This record is a satisfactory one for Britain, and suggests that, if Britain's naval fleet were assailed in war and vanquished, more than the inhabitants of the insular kingdom would have difficulty in getting their food-supplies from over the sea. But this idea may be dismissed; her naval fleet is equal to its task, and, even if it were not so, it could soon be made more powerful, for there is in private yards capacity for building sixteen battleships within three years,—even in two years at a pinch,—as well as twenty-five cruisers, and a complete swarm of those wasps of warfare,—torpedo-boat destroyers. It is the fleet which has the quickest recuperative power that will ultimately triumph.

I have used the word "native" in referring to foreign-owned tonnage, but the term must be qualified. In eight years builders in Britain have constructed for foreign owners vessels aggregating nearly 1,750,000 tons,—an average of 200,000 tons per annum. This includes war-ships; but, if we consider only merchantmen, we find that the average is now more than 150,000 tons, while ten years ago it was about 80,000 tons, and forty years ago only 25,000 tons. An examination of the fleets of foreign powers, indeed, shows the preponderance of British-built tonnage. Including only vessels of 1,000 tons and upwards, I find that in the present German mercantile fleet there are 310 British-built ships; in that of France, 234; Norway, 217; Spain, 171; Italy, 153; Holland and Belgium, 135; Austro-Hungary, 93; Russia, 84; Sweden, 74; Denmark, 65; United States, 23. The greater proportion of this foreign tonnage comes from the Clyde district, whose repute is undoubtedly high: but in this respect, I fancy, it does not by any means so far out-distance the other districts as formerly. This is in some measure due to the wider distribution of Clyde-trained men. I might recall the names of many of my old colleagues at Fairfield and Clydebank now occupying positions of high responsibility in many of the other ship-building centres on the north-east coast of England and at Belfast, but it opens up too great a vista. Moreover, the standard will of necessity improve.

There is no doubt that Clyde practice is an influence, although it might be said of the north-east coast in this connection that the Jews have no dealings with the Samaritans. I shrink from raising any jealous ire. And yet the industry is not of great antiquity on the Clyde. I do not know that any managing partner of to-day can claim that he occupies the establishment of his grandfather, although several firms have lately been celebrating their jubilees,—McMillan



PADDLE STEAMER EMPRESS QUEEN—A TYPE OF AN IMPORTANT CLASS.
Built by The Fairfield Shipbuilding & Engineering Co., Ltd., Govan, 1897.



TWIN SCREW S.S. ROEBUCK STEAMING 20 KNOTS ON A MEASURED MILE.

The Roebuck and Reindeer are sister ships, 280 x 34.4 x 23.6 feet, built for the Great Western Railway Co.'s service to the Channel Islands by Vickers, Sons & Co., Ltd., Barrow-in-Furness.
By permission of J. Adamson & Son, Rothesay.

and Denny's of Dumbarton, Inglis of Glasgow, and others. All the old ship-building firms within the harbor of Glasgow have been crushed westward by the harbor authorities, excepting Inglis: but, after all, Patrick and Govan, where many yards exist, are but continuations of Glasgow, north and south of the Clyde. One might as well say that Fifth avenue is not in New York because its name was not Broadway.

Of the yards existing, Thomson's, now known as the Clydebank Engineering & Shipbuilding Co. Ltd., is the largest in area. It has 75 acres, affording plenty of elbow-room, and employs between 6,500 and 7,000 men. Fairfield is not far behind. Between them they share the honors of the nursery for ship-builders and engineers, and one could not well wish for better tutors than the men who have from time to time presided over the departments. Sir William Pearce was a smart ship-builder and a good man of business. John Elder was an ideal engineer, a good systematic mechanic. Dr. A. C. Kirk had inventive genius, and was a fit successor to Elder. Mr. Bryce Douglas had engineering experience, courage, energy, and great administrative capacity—very essential characteristics. Of these one can speak freely; they are no longer with us. The many Clydebank men now in positions of responsibility readily attribute much of their professional success to the business and professional abilities of their chiefs.

The same fitters were employed on almost all the big Atlantic greyhounds, irrespective of the yard where they were constructed. During the period of competition between the two firms in connection with the Atlantic service, Sir William Pearce was in the full vigor of his professional life, and his methods of meeting the Clydebank ships soon after they were laid down were almost sensational. I do not intend to enter into the narrative, pleasantly reminiscent as it is. The great successes of the Aurania, Alaska, America, Umbria, Etruria, New York, Paris, and, still later, of the Campania and Lucania, are well known: but, as a record of progress, I put down here the length, tonnage, power, speed, and approximate cost of some of the vessels.

Date.	Name.	Length b. p.	Tonnage.	Power.	Speed.	Approximate Cost.
1881	Alaska . . .	500 ft.	6,932	10,500	18	£250,000
1884	America. .	432 ft.	6,500	7,354	18	£190,000
1884	Etruria . . .	500 ft.	7,718	14,321	20	£300,000
1888	Paris.	527 ft. 6 in.	10,499	20,000	21–8	£330,000
1893	Campania.	600 ft.	12,500	28,000	22	£520,000

Of course, each boat was more palatial than its predecessor, and

carried a bigger population,—that is the right word, for the later ships are complete microcosms,—and this partly explains in some way the increased cost, although the great power required for high speed was the principal factor. Curiously enough, only Messrs. Harland & Wolff entered into this contest, and even their ships were few in number. I might also mention the City of Rome, built by the late William John, at Barrow, and the Columbia, built for the Hamburg-American line, at Laird's of Birkenhead. In other speed contests Fairfield and Clydebank have had the opposition of the Dennys of Dumbarton, particularly in twin-screw and paddle steamers for the channel; of Messrs. Laird of Birkenhead; of the Naval Construction Works at Barrow-in-Furness; and of Messrs. Inglis of Glasgow; while the builders of seventeen-knot boats are now very numerous. The estuary of the Clyde has always been noted for its fleet of smart passenger boats, and almost every firm has contributed. The quiet season in journalism is not infrequently enlivened by correspondence and reminiscence concerning the old craft.

The results in the past were no doubt eminently creditable; but the difficulties of adding to nineteen knots increase in a vexatious ratio, so that the meed of praise now due should be the greater. It is no longer a case of rule of thumb; that belonged to an era when speed penalties were not exacted, and when remedies were rough and ready. In one case one and a half knots were added to speed by planing a bit off the wooden paddle floats, enabling the engines to run away easily; another firm, learning the secret, applied the same simple remedy in the case of their next unsuccessful steamer, but it did not cure the deficiency of boiler power, which was the real cause. The irony of it lay in the fact that the floats, being iron, had to be chipped in position, and then had to be destroyed as too small! Now-a-days such methods are too expensive to be relied upon with equanimity, and the position held by the industry in Britain is due to the assurance which past results give to prospective clients of the realization of their requirements. That is why I insist on the point here. Experience does much in this respect; experiment is a grand help, but not a substitute. I recall the case of a twin-screw steamer assumed by some to be of impossible dimensions, but cheerfully undertaken by Messrs. Denny, as a result of tank experiments. Again, there was required within the past two years a paddle steamer for the channel. So onerous were the conditions that several firms considered a twin-screw steamer preferable, and experiment confirmed one or two firms that refused to tender. One firm accepted the order, and had to regret it.

This substitution of the twin screw for the paddle engine in many

cases is really a typical case of the evolution of types, and may be briefly indicated. The beam engine, still beloved in the United States, has long been discarded, although Messrs. Inglis have had, within comparatively recent years, several successes for China. In some respects it is still unexampled, especially in the absence of vibration; but compound diagonal or even triple-expansion engines are preferred. We have reached almost the limit with paddle wheels 23 feet in diameter having floats 9 feet long. The Empress Queen, (page 387) Fairfield's latest triumph, could not be docked in Glasgow, owing to her great beam over the paddle boxes, and yet the biggest screw steamers, mercantile and naval, have been accommodated. The advantage of the paddle propulsion where draught is limited is self-evident; but I have heard of cases of the slip being 26 and even 30 per cent., which is out of all reason. Willans, with his fast-running electric engine, opened a way to the torpedo-boat and channel-steamship builder. By increasing the revolving speed of the propellers, it was possible to reduce their diameter, ensuring the necessary complete submersion with a light draught. Thornycroft and Yarrow did good service, and now, in vessels of the "Roebuck" type (page 388), the engines run up to 164 revolutions, giving a piston speed of 1,066 feet per minute, while the loss by slip is only 13 per cent. at 20¼ knots. Many such twin-screw steamers have been built in recent years, at Clydebank, Denny's, Barrow, Laird's, Fairfield, and Earle's of Hull. The twin-screw steamer has superseded the paddle boat in the Newhaven & Dieppe trade, and in the Holyhead & Kingstown run; it is entering the Dover & Calais service, and is supreme in the Channel Island service; and now, when a new service is spoken of between Liverpool and the Isle of Man, the Roebuck type is preferred to the Empress-Queen class.

Every firm is ready to make experiments, and considerable ingenuity is displayed; but, as a rule, each successive ship of a class is evolved from the experience gained with its predecessor, for, although conditions may alter slightly, the fundamental principle is constant. Success may be qualified; but, after all, more can be learned from an analysis of failure than from success. Messrs. Denny, as is now well known, have an experimental tank for running models and deducing results, after the system first introduced by the late Mr. Froude; and thus they are perhaps able to accumulate data more rapidly than the builder whose observation is confined to the performances of real ships instead of paraffin models. Their tank costs them in salaries £2,000 a year; but the paraffin wax is used time and again. The advantage is in its non-porosity, the ease with which it is planed, the immunity from alteration of form as compared with

wood, which absorbs so much water, and, finally, the fact that there is no temptation to "hoard" useless models. The certainty with which the final result can be achieved is probably sufficient compensation for the outlay; but it stands to reason that, although the process is by no means mechanical, consisting in the application of known laws, there is just a tendency to weaken the imagination. However, there can be no question of its great utility, and, since all builders are careful students of the work of others, there is reason to believe that the models evolved in their tank have had an influence on naval architecture throughout Britain and in European countries generally. But even a tank is of no utility without the experience hardly won, and herein consists Britain's strength.

I have said much about these high-speed vessels, because they are the show-window wares of the British ship-builder. The world too often reverses the Biblical test about faithfulness over small things; the ruler over many things is he who hath done first the mighty deeds. Thus the many other types of ships follow the few high-speed craft. There is the long-distance passenger liner, where high speed is contingent on fuel economy, owing to the distance between coaling stations. The "man in the street" does not so readily appraise the effort involved in keeping down the power and the coal consumption of a Pacific steamer, an Orient, a P. & O., or a South African liner. She may do her 380 sea miles per day, whereas the Atlantic greyhound does 520 or 550 sea miles, but the general reader does not understand readily that the magnificent speed is got at four times the expense in coal and other items in the engine room. And yet these 380-mile ships carry more paying cargo, and are not only the mainstay of the ship-building industry, but in very truth the

Swift shuttles of an empire's loom.

SUPREMACY IN THE IRON MARKETS OF THE WORLD.

By J. Stephen Jeans.

II.—SOME ELEMENTARY CONDITIONS OF SUPREMACY.

IN a previous article we have considered more particularly the relations of Europe to the United States. We may now suitably consider the relations of European countries to each other as rivals and competitors. But we could not say much in relation to the circumstances of the iron trade that has not already been set down or suggested in the report drawn up two years ago by the delegation which inquired into the cost of the conditions of labour in the iron industry of continental Europe—a delegation composed of seven workmen and seven employer representatives, which, as secretary to the British Iron Trade Association, it fell to my duty to organize, and which I served as honorary secretary.

The report of this delegation admits again and again that labour is more steady and reliable on the continent than in England. Strikes, it is stated, are almost unknown in Germany, and the workmen do not make any broken time worth speaking of. On this point the report points one or two obvious lessons. Strikes being very rare, "it is obvious that the steady course of industry in any country has a tendency to give stability and permanence to its operations which could not be expected from other conditions"—that is to say, from a constant liability to suspensions of work by reason of differences between employers and employed. Again, the delegation were greatly struck "with the sobriety, steadiness, and readiness to act upon instructions," of the workmen on the continent, and hence the natural reflection that "the workman who is regularly and steadily engaged at work is not only earning better wages for himself, but is in a better position to do good work, while the effect of such a state of matters on the employer is that he gets the maximum production out of his plant—no heats being lost through broken time, etc." But it must not be overlooked that, although it may not be "stipulated in the bond," the continental workmen have a great amount of consideration extended to them as a reward for this docility and steadiness of conduct. They are assisted to "acquire houses and gardens on reasonable terms, whether as tenants or as owners." Then the majority of the workmen on the continent, at least in the countries visited, are assisted in the matter of State pension and accident-

assurance funds to an extent that is hardly known in England. The State imposes burdens upon German manufacturers from which British or American employers would be likely to shrink with dismay. The delegation found that at one large establishment in the Fatherland the State burdens of all kinds amounted to about £50,000 a year, and at two others, in the same locality, the kindred burdens were £40,000 and £35,000 a year, respectively. These are portentous figures,—almost the income of some grand duchies,—and yet the manufacturers have no remedy, since it is the law of the land. For accident assurance alone the iron and steel industries of Germany have to provide an annual payment of £310,000, or an average of about 10 shillings per worker insured, to which average it has rapidly risen from 3½ marks per head in 1886. We are not surprised, therefore, to find it added that other serious increase of cost has led to several proposals being made and considered, with a view to either diminishing the amount of the indemnities and pensions, or so altering the law itself as to reduce its pressure on the industrial works of the country. But the employers in Germany appear to regard these heavy payments as being to a large extent an insurance of themselves against strikes.

And the obvious lesson taught by the facts ascertained at the German industrial works is the inutility of labour organizations—or, at any rate, of strikes—for the purpose of securing a reasonably high rate of wages. The delegation speaks as if trade unions were non-existent in Germany and Belgium, but, whether common or rare, they have evidently very little influence; yet the rate of wages paid to unskilled labour in Westphalia is stated to be as high as in Great Britain. The labourers in German steel works did not secure their 3s. 6d. to 4s. per day by the force of agitation and physical pressure. No more, for the matter of that, did the labourers in Victoria or Queensland, Idaho or California. The truth is that the rate of wages is a function of the economic conditions prevailing in a particular place or country at a particular time, and the wages are higher in Germany than in Belgium because Germany happens to have better competitive circumstances—at any rate in its iron industry, which, for a number of years, has been exceedingly prosperous. Our trade unions would do well to lay to heart and profit by the facts as to this matter which their colleagues on the British iron trade delegation have disclosed. There is no peril that environs the British manufacturer of which he stands in more dread, or to which he is more constantly exposed, than a strike, and the average employer would esteem himself lucky indeed if he enjoyed the immunities that appear to be the recognized heritage of his continental rival, from this point of view. The

enormous loss, inconvenience, and distress caused by strikes in Great Britain tend to become more and more accentuated and intolerable as industrial operations tend to assume larger proportions. Several of these industrial wars have broken out of late years that have lasted for months, and have caused direct losses that are estimated at many millions. But it is the constant fear of a repetition of these troubles that is the most serious restraining factor in British industry. It is not to be marvelled at if, in view of this constantly-suspended sword of Damocles, manufacturers lose heart, and determine, as many have done of late years, to throw up a game that seems to be so risky and profitless.

One of the most important questions raised by the facts just stated is that of how far the English manufacturers are likely to be affected favourably or unfavorably by the discovery that wages in Germany are much more nearly on all fours with those in Great Britain than they were supposed to be. It might be hoped that low wages on the continent would, by and by, be raised to our own level, and that, as continental workmen became more and more *exigeant* in their demands, their range of wages would become more or less identical with that of their English brethren. But this view cannot be maintained in face of the ascertained fact that wages do not much affect the situation,—at least so far as Germany is concerned,—and that other causes have a more powerful influence in enabling competitors to secure a firm footing in markets which, judged by every consideration of interest and reciprocity, should be exclusively British, or nearly so.

Another essential difference in the conditions of carrying on the commercial arrangements of continental industries as compared with British is founded on the existence on the continent of the system of protection. The customs duties levied on imports into Germany, for example, protect the German manufacturer from competition in his own market, so that he can always depend upon securing, within the limits thereby prescribed, a satisfactory price from his home customers. This result, as is proved by the recent experience of the United States, would not necessarily follow without a certain amount of organization, but the Germans are adepts in the art of accommodating themselves to circumstances, and they consequently have a whole legion of syndicates designed to regulate production and price in the different branches of trade and industry. The evil of overproduction is thereby kept in check, and prices are well under control. The home business, in short, is made so profitable that manufacturers can afford, if necessary, to lose on export orders, which they often do, for the double purpose of building up a trade, and keeping their manufacturing establishments and their workmen

fully employed. There is much method in this arrangement. With production on a large scale, standing charges are kept down, and the cost of manufacture is lessened, while the workmen, having full and regular wages, are not likely to be so difficult to handle as they would be if—as often happens in England—they were employed only to the extent of one-half or two-thirds of the full time. Of course, in so far as Germany, or any other country, sells in neutral markets at less than cost, it is not fair competition. It could be effectively met only by the adoption elsewhere of a similar economic system, which, however, cannot be looked for in England, wedded as she is to free trade, whatever consequences that system may involve.

The British iron trade delegation appears to have arrived at the conclusion that the greatest factor in favour of the foreign producer is the much lower cost of transport, and they express the opinion that, "if English manufacturers enjoyed the same railway rates and royalties as those on the continent, foreign competition could be defied in neutral markets." The natural inference is that it is the British railway companies that have been the most persistent and successful instruments in strangling British trade, and that they have in this been aided and abetted by the owners of the soil, whose charges for royalty are greatly higher than those paid in any continental country. This is not a new discovery. What is new is the knowledge that it was a much more potent cause of the ills from which we suffer than either the lower wages paid in continental countries, or any other contributory cause. The report quotes figures to show that, while the long-distance rates in Great Britain run from a penny to a penny halfpenny per ton per mile, similar traffic is carried on over similar distances in Belgium and Germany for a halfpenny or less. In other words, the English rates are, in many cases, about three times the rates charged in competing countries. This, of course, makes an enormous difference to English trades and manufactures—a difference that may be better understood when we add that the total income of British railways from mineral traffic is about nineteen millions sterling a year, or very nearly as much as the whole realized value of British exports in iron and steel. It would be absurd to say that the railway companies of Great Britain could at once, or at any future time, be expected to carry heavy traffic at the low rates common on the continent. Besides the immense differences that obtain in the capital cost of the railways, and must be provided for, in the case of private ownership, by corresponding rates and charges, there are essential differences in the conditions under which the traffic is carried. The English railways generally carry for short distances; the American and continental railways generally carry for long distances.

The cost of handling the traffic is, however, much the same whether the traffic is carried for long or for short distances, and it makes a vast difference in the actual cost of transport whether the traffic is handled, say, once in five miles or once in fifty. It would, therefore, be a delusive hope to suppose that British traders can ever see exactly the same rates and charges that continental manufacturers enjoy; but it would, nevertheless, be possible to modify the existing tariffs, for long-distance traffic, in a material degree, so as to enable Midland manufacturers to obtain easier access to the sea; and this would greatly aid them in their export trade. If Staffordshire traders, for example, could reach London and Liverpool as cheaply as German manufacturers can reach Antwerp, Hamburg, or Rotterdam,—assuming approximately equal distances,—the traders of Wolverhampton, Dudley, and Birmingham would not be likely to require much more to enable them to hold their own. British railway companies may be able to arrange for this desideratum, and for giving cheap access to ports in all cases where the distance is more than forty or fifty miles, without materially altering their rates to works that are already on the seaboard, and whose transportation charges are already perhaps low enough to enable them to compete without much difficulty,—such, for example, as the traders of South Wales and Cleveland. But British trade has suffered grievously because the British railways have failed to encourage and facilitate the export trade as continental railways have done. It may be answered that the lines on the continent are controlled by the State, which is not compelled to pay dividends, whereas the primary function of the privately-owned railways of Great Britain is to return dividends to shareholders. But, if the interests of railway shareholders and national industries of the first rank are found to be incompatible, then it seems only common sense to argue that the former must give way voluntarily, or be forced to it.

Having now considered some of the more general aspects of the conditions of competition between the leading countries of Europe, we may proceed to examine their resources in raw materials, and the conditions of their supply.

Cheap raw materials are, of course, a fundamental requirement of successful international competition, and the country that possesses the largest store of such materials, all other things being approximately equal, is certain to be at the front in the long run. For this reason, it is important to consider not only the existing state of development of the iron industry, but the possibilites of future development. Regarded from this point of view, and on this basis, it might conceivably happen that the center of the world's iron production in the future would turn out to be some country, such as China or

Japan, in which, at present, the metallurgic arts have been very imperfectly developed. Meanwhile let us deal with the facts that are known.

Great Britain.—The average cost to the smelter of the iron ore raised on the west coast may be taken, including 2s. for transport, at 13s. 6d. per ton for the ores of West Cumberland, which corresponds to 3d. per unit, and at 11s. per ton for North Lancashire ores, which corresponds to 2.6d. per unit. In the Cleveland district, which is the main source of supply for home ores, the average cost of ores at the mine is 3s. and, if we add a shilling per ton to this figure for transport, it brings the average cost of a 30-per cent. ore up to 4s. at the furnace, or 1.6d. per unit. It is not easy to state the average percentage of iron in the home ores of the United Kingdom as a whole. In 1896, according to the government returns, the quantity of pig iron produced from home ores was 4,759,446 tons, and, if we take this as using 100 units per ton, it would bring up the average of the whole home ores in the country to 35 per cent., which is probably as near as we can get to the actual truth. The average cost per unit at the mines of the total iron ore production of the United Kingdom will amount to 1.54d. per unit, assuming this average of metallic iron, and the government average of value at the place of production, which is 4s. 6d. per ton; but to this figure has to be added the cost of transport to furnaces, which is not less than 1s. 6d., and this would bring the average cost of the ores at the furnaces to 6s. per ton, or 2.06d. per unit. The total production of British ores in 1896 from mines under the coal mines regulation act was 7,856,586 tons, or 60 per cent. of the total output of iron ores of all descriptions; and, as the government returns estimate that these cost 4s. 1d. per ton, and have an average of 30 per cent. of iron, the average cost per unit must be 1.6d. at the mine.

Something like thirty-three per cent. of all the pig iron produced in Great Britain is made from imported ores, chiefly those raised in the north of Spain, which cost at English ports from 11s. to 15s. per ton, according to the condition of the trade and the rates of freight, and contain from 45 to 52 per cent. of iron. If we take the average at 12s. 6d., it will be near the mark, and the average content of iron in the ore will probably be 48 per cent. This means that the average cost of imported ores at the furnaces is about 3¼d. per unit, which, it will be noted, is considerably above the average unit cost of home ores. Adding together the imported ores and the west coast hematites, it appears that about 3,500,000 tons of iron, out of a total of nearly 9,000,000, is produced from ores that will average about 50 per cent. of iron. This is a higher proportion of bessemer iron than is used in France, Belgium, or Germany, but of course it falls

much below the average of the United States, which in 1895 produced 10,500,000 tons of ore from the five Superior regions, averaging perhaps about 60 per cent., and representing therefore more than 6,000,000 tons of pig iron.

Germany.—Germany has never made any great pretensions to be a cheap iron-making district. Nevertheless she produces some of the cheapest iron made in any part of the world. This is more especially the case at the works of the Peine Company, in the province of Hanover, where basic pig iron has been produced for twenty years or more at a cost of about 25s. per ton. The quantity so produced, however, is small, not exceeding 250,000 tons a year. Next to this in cheapness is the product of Alsace-Lorraine, where the average value per ton of the 829,000 tons made in 1895 was returned officially at 32½ marks, and following Alsace, on a large scale, comes Luxembourg, with an output, in the same year, of 695,000 tons, officially valued at 37s. per ton. By far the largest output of iron in Germany is, however, drawn from Westphalia. The Bonn and Dortmund districts unitedly produced in 1895 more than 3,000,000 tons, or nearly 60 per cent. of the total output of the empire. The average value of this output is estimated at about 44s. 6d. per ton, and the average of the whole pig iron output of the empire is officially recorded at 42s. 10d. ($10.41) per ton. This does not compare unfavorably with the average value of British iron at the same date. The bulk of the iron produced in Germany is basic, and Cleveland basic iron varies from 42s. to 45s. per ton. German hematite, or so-called bessemer, iron is quite as cheap as the corresponding quality in Great Britain.

Germany cannot be said to enjoy the most suitable conditions for the manufacture of cheap iron. In the chief iron-making district, Westphalia, the ore has mainly to be drawn from three districts,—Alsace, Luxembourg, and the Meurthe-et-Moselle. All of these districts are far removed from the coal and the blast furnaces of Westphalia. Railway transport consequently brings up the cost of the ore at the furnaces to about three times its value at the mine. In other words, the cost of the ore required to produce a ton of basic pig in Westphalia is not less than 18s. per ton, against about 14s. in Cleveland, so that here there is a distinct gain for the British maker. It is true that considerable quantities of pig are produced in Alsace-Lorraine and in Luxembourg, but in both cases the fuel has to be carried a long way to the ore, and the conditions of transport distribution are in neither case so favourable as in Westphalia, where, consequently the pig iron industry has witnessed its largest development. Beside the ores available within her own borders, in which Lux-

embourg is included as part and parcel of the Zollverein, Germany imports considerable quantities of both basic and bessemer ores—the former from the Meurthe-et-Moselle, to the extent of about 1,250,000 tons a year, and the latter from Spain and Sweden, to the extent of about 750,000 tons annually. The German imports of ore, which aggregate more than 2,000,000 tons a year, are not much more than one-third of those of Great Britain, but they are much larger than those of any other continental nation, including France, which now imports nearly 1,750,000 tons annually. The Meurthe-et-Moselle ores are abundant and cheap. They run to about $\frac{1}{10}$ per ton at the mine, but, before they are delivered in Westphalia, they cost quite as much per unit as the ores of the Lorraine and Luxembourg. So far as the importation of bessemer ores is concerned, Germany stands at a disadvantage in comparison with Great Britain. All such ores have to be transported by sea, and the iron works of Westphalia are not so favorably situated for water-transport as those of Cleveland, Wales, and Scotland, which are practically on the seaboard, although the Rhine freights are very low, and canal freights off the Rhine are much lower than shippers have any experience of in Britain. It is possible, in the main, that the difference against Germany will not be more than 1s. to 1s. 6d. per ton, which would mean 2s. to 3s. on the ton of pig. It is a notable phase of the recent history of the German iron industry that it has used a much larger proportion of Swedish ores than Great Britain, which depends mainly on the north of Spain. Krupp, however, has a large interest in the Orconera Iron Company,—the chief mining enterprise in Spain,—and imports a very considerable quantity of Orconera ores to his works on the Rhine at probably as low a price as is paid by any of the works in Wales or Scotland.

The greater distances that intervene between the ores and the fuel are a serious disadvantage to Germany. In no case is the distance much less than a hundred miles, and in many cases it is much more. In Great Britain only one district is subject to this serious disadvantage,—namely, the West Coast, which draws its main supplies from South Durham, on the other side of the island, and well on to a hundred miles distant, at a cost for transport of 6s. to 7s. per ton. On the other hand, Cleveland is within thirty miles of the important coal field of South Durham, whence she draws her fuel supplies at a cost of 2s. 6d. per ton for transport, and in South Wales and Scotland, as well as in some of the Midland districts, the blast furnaces are built on the coal. Throughout Great Britain, indeed, cheap fuel is, with rare exceptions, the general rule, and where iron-making firms produce their own fuel, as many do, the cost of this item must be relatively small.

Belgium.—Perhaps no country on the face of the earth has ever

attained to a position of eminence in the face of such disadvantages and discouragements as Belgium. She has now practically no ores of her own, and her home supplies were always poor and dear. Consequently she is compelled to import the great bulk of her requirements. Her coal is generally inferior to that produced in any other European country, and so difficult to mine that a Belgian hewer cannot produce much more than one half of the annual output per hewer in Germany or Great Britain, or the United States. Belgium was also originally badly off for ports, and even now she can be said to have only one of any consequence. Her coal fields, again, were a long way from the sea, so that, if works were built on the coal, they had to suffer the disadvantage of a long railway or canal transport for export purposes. Yet, in spite of all these and other disadvantages, the little kingdom has won a place of no small importance among the iron-making nations of Europe, and competes with Great Britain and to some extent with the United States, on their own soil. This result has been accomplished by dint of very great industry and exceptionally economical labor, as well as by an energy and enterprise that deserve high praise.

Practically all the large iron works in Belgium are situated on the coal fields, mostly on those of Liège and Charleroi. The Luxembourg ore usually costs about 6s. to 6s. 6d. per ton at the works in the Charleroi district, which is about the Westphalian average, but less by at least 15 per cent. taking the quality of the ore into account, than the Cleveland ores cost the smelters of Middlesborough. The Belgian pig makers have to bring a 35 per cent. ore distances varying from 100 to 130 miles; the coal, which is got on the spot, or nearly so, costs 6s. to 8s. per ton at the furnaces, the cost at one works which I visited, only about 1¾ miles from the collieries, being as much as 7s. 11d. per ton. This compares curiously with one works I know of in the neighborhood of Pittsburg, some twenty miles from the collieries, where the coal is delivered at furnaces for less than 2s. 6d. per ton, and it also compares unfavorably with all the British works, except those on the west coast. At another works I found that the average cost of coal, including slack, at the pit's mouth, over a period of six months, was as much as 7s. 7d. And yet these same Belgian workers can produce pig iron for £1. 15s. to £1. 17s. 6d. per ton ($8.50 to $8.63).

Of course, Belgium, as will be inferred, makes up for costly raw materials by low rates of freight. Ores are carried a distance of 130 miles for about 4s. per ton. Bar iron is carried more than a hundred miles for 3s. per ton when destined for export. Low freight rates and low wages are the salvation of the country. I must leave until another occasion the consideration of the competitive conditions of the United States and one or two other countries.

THE PROTECTION OF SHORES AGAINST THE ENCROACHMENTS OF THE SEA.

By E. L. Corthell.

WE are accustomed to consider the old Dutchman to be the great and successful sea-fighter, whose habits of vigilance and continued effort in the midst of grave danger and in the presence of a powerful enemy gave him the persistent courage to combat for a century or more the legions and the power of Spain. The facts of history do not justify this opinion. He may have been, and he was, a redoubtable fighter against foreign rule and oppression, but he never successfully attempted to cope with the sea. He built a wall of earth about his farm, set his wind-mill at work to pump out the water, spread black soil over the sandy parts, and raised his crops while the surrounding lands were flooded ; but further he did not go. As an illustration of this condition, the city of Alkmaar, which means "All Sea," was originally a bit of higher land, with lakes all about it. This large area of country was reclaimed by building about it an extensive levee, almost circular in form, pumping out the water, digging drainage ditches, and making farms. This became then the seat of the old kingdom of the counts of Holland ; but the encroachments of the sea were never combatted. The real hero of Dutch history is the engineer of the last half-century. It was only after 1860 that he said to the sea : "Thus far shalt thou come, but no farther." None of the generations preceding had the nerve to say this, or the skill or resource to make the sea obey the command.

The North sea continually encroaches upon the beaches and cliffs on both its east and west shores. Nearly the entire coast of the counties of Norfolk and Suffolk, in England, is melting away before the waves in greater or less rapidity. The sea slowly, but surely, removes the bluffs, which slip and slide, carrying with them villages and towns that, in the olden time, were among the more important of the kingdom. At Cromer, for instance, the waves break over heaps of *débris* which once were the brick wall of a lighthouse. The Cromer of old Roman times cannot be located. It is said to be two miles out at sea. In Suffolk the little old-world village of Dunwich is only the remains of a once flourishing town. King Sigebert, of East Angles, had here the seat of his government. In the Norman conquest it began to feel the encroachments of the sea. Even during the reign of Henry the Second it had a great reputation and was very

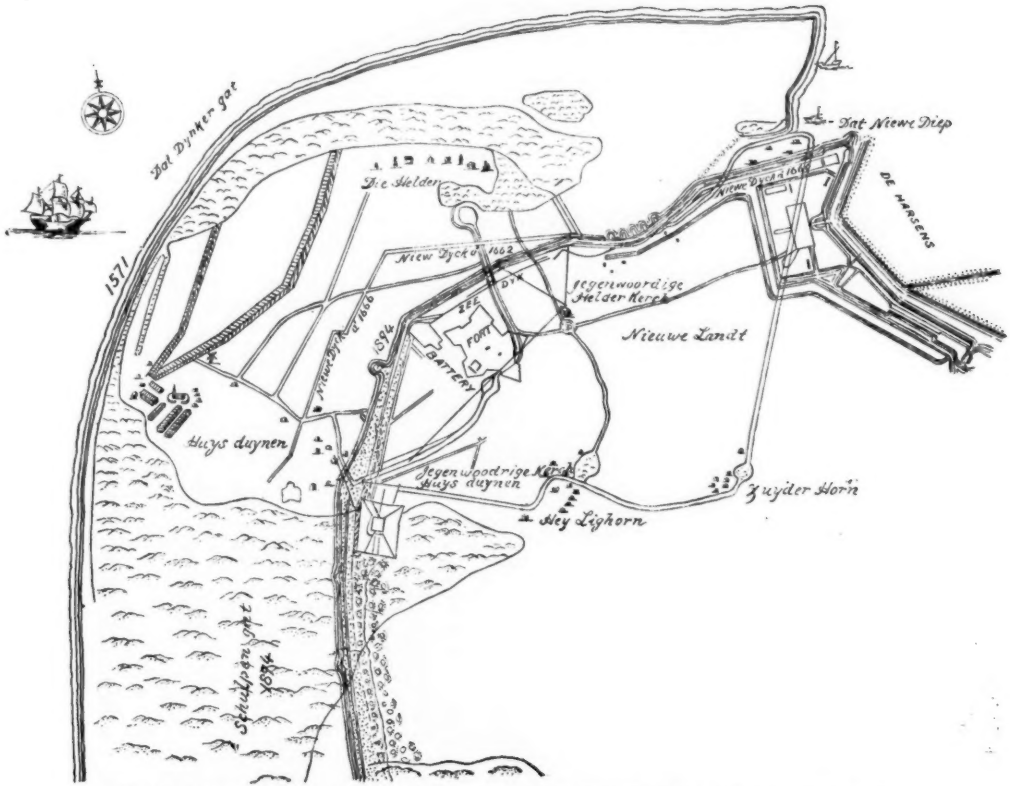
rich, with fortifications of sufficient strength to defy the invading troops of Henry's son. In the days of Edward I it maintained eleven ships of war. Then the sea went to work in earnest; it first blocked up the port with sands,—about 1328,—and, in a comparatively short time, swept away more than four hundred houses; then a church went, then a monastery, then at last the jail. In the time of Elizabeth four out of six churches had been drowned in the sea. In 1891 the population had shrunk to two hundred and thirteen, and those live in terror in a straggling little village in an inland valley, whither they have fled from the all-conquering and advancing sea.

On the opposite shore of the North sea, about three hundred and fifty miles distant, the same process of decay of the land, and the destruction of its cities, went on until about 1860. The writer, through the courtesy of one of the Dutch engineers, is able to reproduce in THE ENGINEERING MAGAZINE (p. 404) a historic chart, long out of print, which shows the changes in the coast line and in the cities and cadastral features since 1571. A map of Holland will show the precise location of Helder, which is its most northern main-land city.

The outer shore line of the historic map is that of 1571, more or less accurate. The inner shore line is that of 1894, which is the present one. This line has been effectually held since 1866. The old sand dunes of three centuries ago are plainly seen, as well as the successive retirements of the population from the ever-encroaching sea. The town of Huisduinen is now 1,500 meters from the shore line; the old Helder 1,000 meters; both buried in the sea, the waters covering all that may be left of once flourishing towns. The lines of old dikes, the results of half-hearted efforts to brave the sea, appear on the map. Farther south the same conditions exist, though in a somewhat modified form. Opposite Leiden, not far north of The Hague, there is said to be still an old castle, or the ruins of one, far out at sea. It was built in Roman times, before Christ, and was discovered by the surveys of about a century ago; since then there has been no indication of it, though no doubt it is there yet.

At Scheveningen, the watering-place of Holland, near The Hague, and all the way south to Ymuiden, the sea-entrance of the Amsterdam canal, the sea has, until recently, constantly encroached on the land; and the old charts of the eighteenth century show the shore a kilometer distant from its present position. On the island of Walcheren, and on the main land as far south as Ostende in Belgium, the same effects of the sea are found.

The principle on which engineers of the present generation have based their plans and methods are simple and effective. The great destructive forces of nature have been skilfully turned into construc-



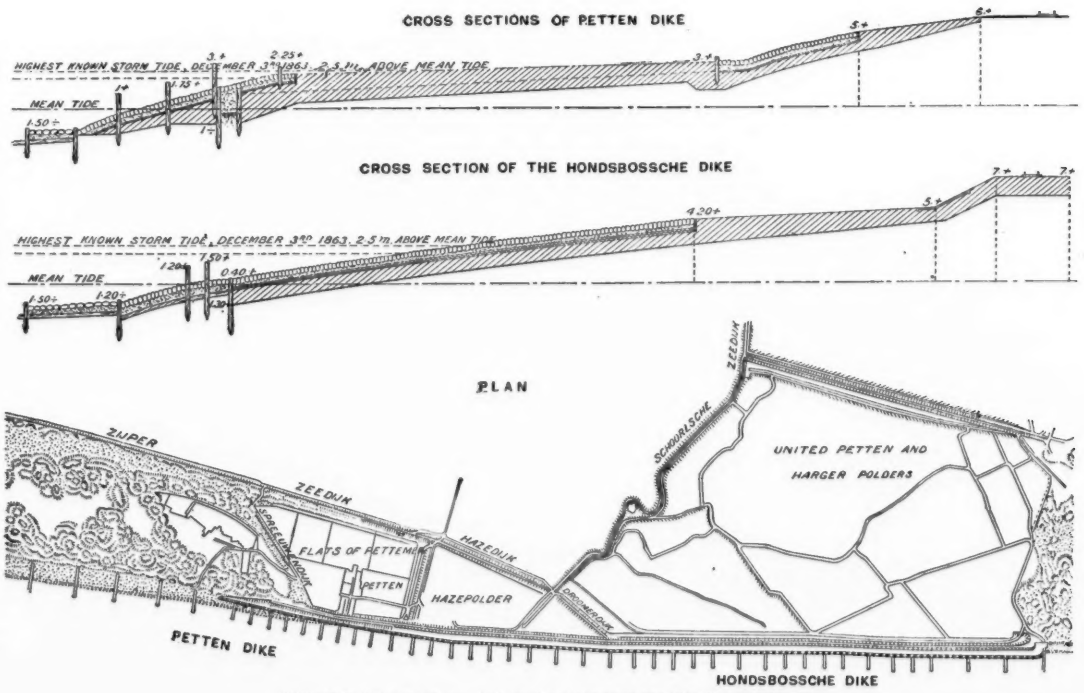
THE COAST OF HUISDUINEN, HELDER, AND NIEUWEDIEP IN 1571 AND 1894. FROM AN OLD CHART.

tive forces. Appreciating the fact that the high chalk cliffs of England are no protection against the sea, they did not attempt to place an artificial vertical wall against the waves and the storm tides, but coaxed the sea to deposit its sands on the shore and so build it up, rather than throw them inland and then, hungry for more, eat into the shore. They believed it best to satisfy its appetite, but induced it to toy with the sands which its own flood-currents and waves bring

from other shores and from the offing depths. The sand thus deposited blows, in the gales, over the inland country. The engineers induced it to stop and build a barrier for them against the sea. One of the heaviest dikes along the coast was built by the winds themselves.

Illustrations of the works at many different points might be given, but one will suffice, especially as it is one of the best examples of the methods employed. It is at the small village of Petten, about fifteen miles north of Alkmaar, and not far west of the North Holland canal, which traverses the country almost due north from Amsterdam to Helder. The lower marginal line of the sketch is due north and south. The sand dunes are sketched at the right and left, between which is the sea dike, built many years ago, but entirely reconstructed from 1870 to 1880. Its length is 5,500 meters (18,000 feet), of which 4,500 meters is under the charge of the Polder (an area or combined areas of embanked land with its own local government, like a town or city) and 1,000 meters under the charge of the federal government. The Polder dike cost 2,250,000 florins ($904,500) and the government dike 500,000 florins ($201,000). The government furnished 4,000 florins toward the expense of the Polder dike, and the province (State) 4,000 florins. The remainder of the cost was put upon the lands and other property of the Polder under a general law of Holland, which also authorizes the issue of long-time securities or bonds. There are twenty-nine Polder jetties and nine government jetties, with eleven more government jetties built further north. The upper cross-section is the sea-slope of the government dike, and the lower that of the Polder dike. The land slope is about 2 to 1, and it and the crown of the work down to 5 meters (16.4 feet) above mean high tide, which is 0.68 meters (2.23 feet) above A. P. (Amsterdam Peil, or mean level of the sea as established at Amsterdam), is turf, except where paved with stone. The hatched area is a tough clay obtained at some point inland and spread over the sand or other material forming the interior of the embankment, which is obtained from borrow pits on the inside at some distance from the work. As the government section is rather more scientifically planned and built, the description of the details will refer to it.

The entire slope, up to the 6-meter height, is liable to have a sea upon it. The waves of the storm of December 12 and 13, 1883, reached to 5.7 meters (18.7 feet), and the level of the water December 3, 1863, was 2.50 meters (8.2 feet) above mean high tide. The rock-work of the surface of the slope is entirely of basalt, which is used everywhere in Holland,—found at Andernach, on the Rhine, in Germany. It is always hexagonal, and usually eight to eleven inches in thickness. It is columnar when in position. The columns are



SECTIONS AND PLAN OF THE SHORE-PROTECTION WORK AT PETTEN.

broken off into lengths of twelve to eighteen inches, and are placed on a mat or filling of small, lithe, osier willows, which are either made into fascines or bundles, about 5 inches in diameter and sometimes of great length,—40 to 60 feet,—or packed in layers on the clay slope, as shown in the sketch. A row of stakes is driven firmly into the clay to separate the rock-slope from the clay surface adjoining. The long flat clay slope between this rock covering and the sea-slope is overlaid every autumn, after the threshing season, with wheat straw, which is laid in layers, like shingles, except that the butts are covered over, and the layers are fastened down to the clay by withes of straw laid parallel with the dike and pressed into the clay about six inches every six inches of length of the dike. This is done by means of a peculiar iron tool, or chisel, the end of which is hollowed out in circular form to catch the straw withe and jam it down into the clay. The covering of new straw presents a beautiful appearance, and feels under the feet like a soft carpet. It maintains itself under the storm wave-action about a year, when it becomes rotten. It is then pulled out, and a layer of new straw put down. This is less costly than the use of basalt, as the latter is expensive.

The sea-slope proper is much more solidly and permanently built; the rock is packed tightly, and the stakes, or small piles, are much larger, and stand up higher above the pavement. They are about one foot apart, and their diameter is five to six inches. The object of these is two-fold: to assist in holding the stone in place,—there are four rows standing above the rock-slope and four flush with the surface,—and to break the waves without stopping them, and thus protect as much as possible the flat straw slope above.

It will be seen from the section that the work extends from about 2 meters (6.5 feet) below the mean high-tide level to 6 meters (19.7 feet) above it, or a total height of 8 meters (26.25 feet), and is, including the inside slope, about 77 meters (253 feet) in width. The entire slope averages 1 in 8; but the matted slope, 27 meters (88.6 feet) wide, has a slope of only 1 in 40, while the foreshore of pitched basalt next to the sea has a slope of about 1 in 4.

This construction, however, is comparatively simple. The real effective effort is in the construction and maintenance of the forty-nine spur jetties, or groins, shown on the plan. These are generally spaced about their length apart, or possibly a little more,—say 1¼ times the length of the dikes. They are built of willow mats made of fascines, and loose willows pinned and packed down solidly, with a covering of basalt about eighteen inches in thickness. With a less thickness than this, the waves will churn up and pull out the stones. There are usually, lengthwise of the jetty, six or eight rows

of stakes, not far apart, driven down until the tops are flush with the stone. The interstices between the stones very soon become packed with barnacles and masses of small black shells, which materially assist in holding the stones in place. The jetties are generally about 105 meters (350 feet) long and 12 meters (40 feet) in width. One of the first and desired effects of these jetties is to make a deposit of sand between them, extending from the shore line to and beyond their outer ends, in many cases covering their side slopes and securely protecting them. The extreme ends are the only exposed points, and these need considerable maintenance-work. Small piles in squares are driven by hand through the end of the work, which serve the same purpose as the piles driven in the embankment slope above described.

The sand formed between the jetties becomes dry in sunny weather, and the surface is blown ashore when the wind is in that direction. It was desired to build a strong dike to connect with the sand dunes. This was accomplished by setting in the sand, in rows about a foot apart, tufts of the dune sea grass near by. The tufts were placed about a foot apart,—simply little handfuls of grass; the place for each tuft was dug out with the hands, the tuft set into it, and the sand pressed around it. The whole surface of the dry, sandy beach above high tide was covered with this plantation, and, just back of it, at the highest point of the existing sandy area, one or two rows of reeds were set into the sand, their tops cut off, and the stalks left standing about four feet above the sand. The sand, drifting along over the surface, catches and in one windy day will almost bury the tufts of grass and stand up a foot along the rows of reeds. Then another plantation was made, and another, until a massive dike was built up to the height of the adjoining dike. In high storm tides the waves will eat into the toe of the slope and pull down the sand, but, by the same process of building, the dike is again restored to its former size.

The shore immediately south of the southern end of the main dike and the last groin shown in the sketch some time ago showed signs of the encroachment of the sea. The plan of planting tufts of grass was adopted for a long distance, very successfully, holding the shore in position. The cost of maintaining the entire work, Polder and government, is about 25,000 florins ($10,050) per annum. Considering that this is the key-work for all this part of Holland, the expense of maintenance is very small.

About midway of the work is seen an interior dike, called "Droomerdijk," striking the main dike diagonally. This diagonal dike formerly extended in its present direction a long distance into the sea, possibly at a time when, as at Huisduinen, the country was protected by a mass of high sand dunes. These dunes often attain a

height of one hundred and fifty feet above the sea, and form a mass of hills and valleys. The dunes shown at the right in the sketch are of this character, and, along the road leading from the shore and skirting their base, are several very pretty villages, protected from the winds and having in front of them the lands,—the rich polder,—which, as shown by the name, "Pettemer," was formerly a sea.

The principles, methods, plans, and details do not differ materially along the whole coast, from Ostende to the Dutch Islands north of the main land, covering a coast line of nearly two hundred miles.

The natural and artificial conditions are full of interest. First, the peculiar movements of sands in the flood currents up the channel and along and in front of the French and Belgian shore, attempting always to close any artificial outlets, like those at Calais, Dunkirk, Gravelines, and Ostende. These moving reefs of sand back up against the works, and then move around the ends of the piers into the channel, obstructing navigation if not removed by dredging. At a distance from the shore these reefs require removal. They seem to be moving northward up the coast to furnish material with which the sea may build sand dunes along the Holland coast; for the supply of sand there seems almost inexhaustible.

Second, the action of the sea upon the shores,—in one place building, in another tearing down. Not far north of Ostende, the shore, some time ago, was washing away; a huge masonry dike was built to stop it; and then, by one of those peculiar periodic reversals of policy which sometimes possess the sea, as we find it on that wonderful coast of Coney Island, the currents and the waves and the winds formed a combination, buried the dike deep under a sand dune, and built a hill in front of this masonry wall. Thus to a stranger the object of the dike does not appear at a glance. Not far north of this same point the shore, and the dunes with it, are receding at the rate of seven feet per annum.

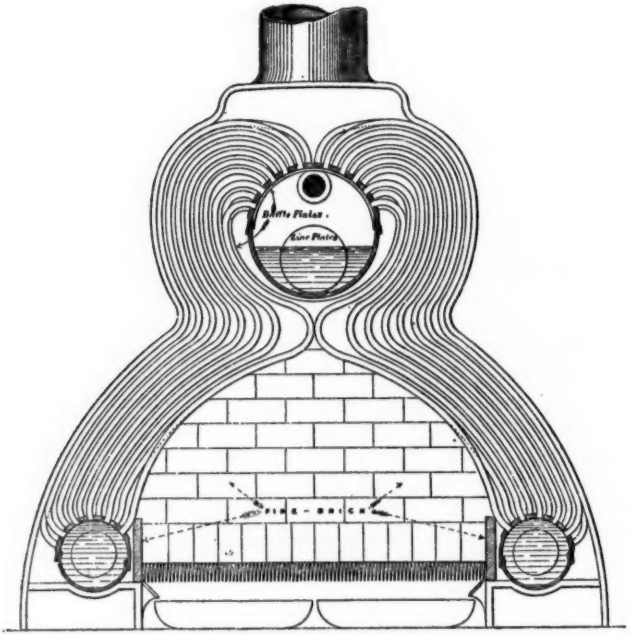
Third, that shore which we have specially treated in this paper, where the sea is everlastingly encroaching upon the land; where currents and waves and winds seem to conspire to destroy it; but where, often by the frailest of works and most perishable of materials, skilfully employed, the Dutch engineers are victors in the long, hard battle with the sea and its allies.

THE STATUS OF THE WATER-TUBE BOILER IN THE AMERICAN MARINE.

By Walter M. McFarland.

THE two items of greatest interest in connection with marine machinery at the present time are, probably, water-tube boilers and the steam turbine. The latter, for marine purposes, was not long since spoken of by a distinguished engineer in London as an interesting toy, but the former is the subject of the most careful and painstaking study, design, and experiment by many of the most talented engineers in the world. Indeed, so great is the interest in water-tube boilers that we seem on the eve of a revolution in the marine steam-generating plant, and in the navies of at least two of the great powers the revolution has been so far accomplished that for new designs the cylindrical boiler has been definitely abandoned. To understand how this has come about, a brief consideration of the history of this well-tried type will be profitable.

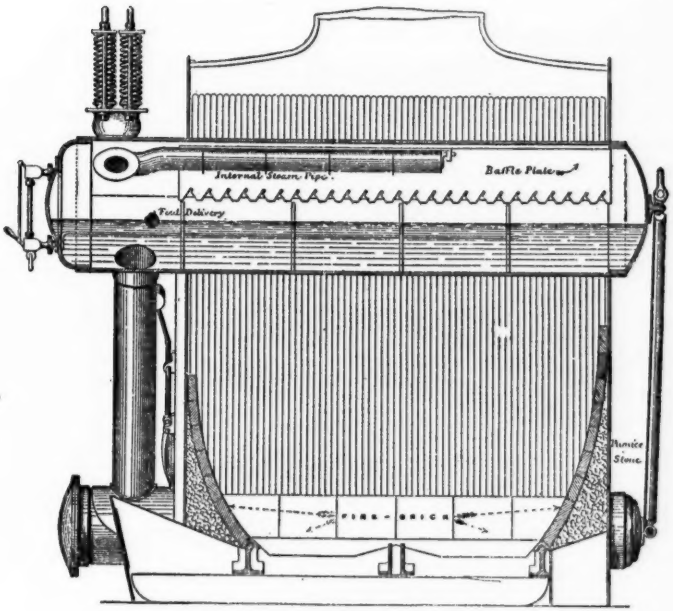
Evolution is not restricted to biology, in spite of the fact that, to many, it is almost synonymous with the views of Darwin and Huxley; and it can be easily traced in the history of boilers. In early days, when steam pressures were low, boilers were of almost any shape, depending for their strength on bracing rather than thickness of shell. As pressures rose, a time came when the braces would have been too close to permit access to all parts of the boiler, and this naturally led to a form where the envelope could furnish the necessary strength by its thickness, and dispense with bracing. This brought in the cylindrical, or Scotch, boiler, and, after some years of trial of various details, a few standard types gained general adoption, variation being mainly in size. About the time that mild steel came into general use, pressures had risen to the permissible limit for shells of wrought iron, but the new material enabled the progress with higher pressures to continue. Improvements in manufacture of material, in boiler-making appliances, and in design enabled the cylindrical boiler to answer every demand upon it, until pressures as high as 225 pounds, for boilers that may not inappropriately be called huge, are actually in use to-day. The boilers of the Campania are 18 feet in diameter and 17 feet long, and the shell plates are nearly 1⅝ inches thick, some of the individual plates being 20 feet long and 7 feet wide; the working pressure is 165 pounds.. The St.



THE THORNYCROFT WATER-TUBE BOILER.
"Speedy" Type, Front View.

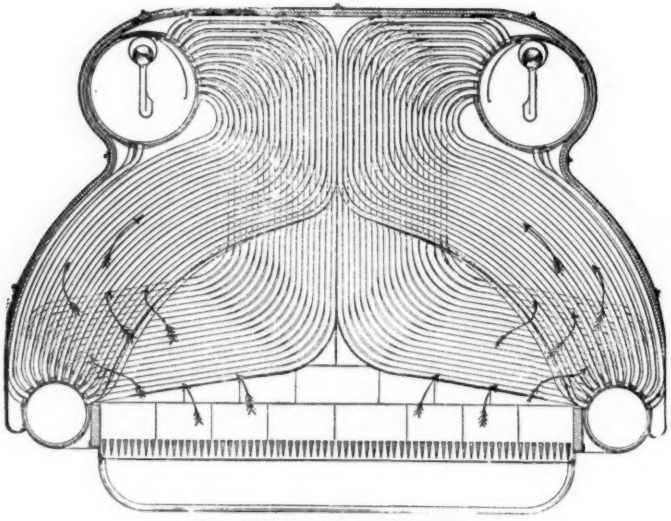
Louis and St. Paul, with a working pressure of 210 pounds, have boilers 20 feet long and 15 feet 7½ inches in diameter. The main boilers of the U. S. S. Minneapolis are 20 feet long and 15 feet 9 inches in diameter, and weigh about 72 tons each, empty. The water in one boiler weighs about 40 tons.

Two of the disadvantages of the cylindrical boiler are here shown very clearly,—the great weight of the boiler itself and of its contained water. The figures themselves are striking, but a tabular comparison farther on will emphasize the great weight for a given power. Incidentally it may be remarked that these large boilers require a large plant with massive tools for building them. It will be readily appreciated also that a structure composed of so heavy plates must be very rigid, while the ideal boiler should be very flexible. This rigidity necessitates ample time and considerable care when raising steam, and when allowing it to fall after the boilers are no longer needed; in the attempt to equalize temperature throughout the structure, special devices for circulating the water are almost invariably



THE THORNYCROFT WATER-TUBE BOILER.
"Speedy" Type, Longitudinal Section.

employed. Hauling fires, except in an emergency, is no longer permitted, as it certainly causes leaks. It is practically certain, too, that the limit of steam pressure with cylindrical boilers has been reached. Although a few large vessels are in use where cylindrical boilers carry more than 200 pounds' pressure, the pressure generally does not exceed 180 pounds. For these high pressures the work of building a large boiler is difficult and expensive, and requires a costly plant. It is to be noted also that the great weight of water in these large boilers is an element of serious danger in case of an explosion, although happily there is, as yet, no record of a modern, well-designed, high-pressure boiler having exploded,—a very creditable thing for all concerned in design and manufacture. It was Dr. Thurston, I believe, who said long ago that a cubic foot of water heated to a temperature corresponding to 60 pounds' pressure had as much explosive energy as a pound of gunpowder. At the higher pressure now carried this would be increased by about twenty-five per cent. While there have been no explosions of the boilers, there have



THE MOSHER WATER-TUBE BOILER.
As used on the "Feiseen," "Norwood," and other swift boats.

been ruptures of the steam pipes, and the large amount of highly-heated water has continued to fill the adjacent compartments with steam, sometimes for several hours, thus preventing any succor reaching those who, but for this, might have survived, although badly injured.

It thus appears that the defects or disadvantages of the cylindrical boiler which have made themselves felt and have called for a remedy are:

Inadequacy for pressures higher than about 200 pounds.

Great weight of the boiler itself.

Great weight of the contained water.

Excessive rigidity, entailing time and care in raising and lowering steam.

Slowness in raising steam,—a great defect in war vessels.

Disastrous results from an exploded boiler or ruptured steam pipe.

To reduce the weight of boiler and water per unit of power, recourse has been had to forced draft, and, while this has accomplished its aim to a certain extent, it has been accompanied, in many cases, by injury to the boilers, and, when the amount of coal burned compared to the heating surface has been high, it has always caused a decided reduction in the economy of evaporation. This will be seen

from the annexed table and diagram, which, although made from trials of a water-tube boiler, are true generally.

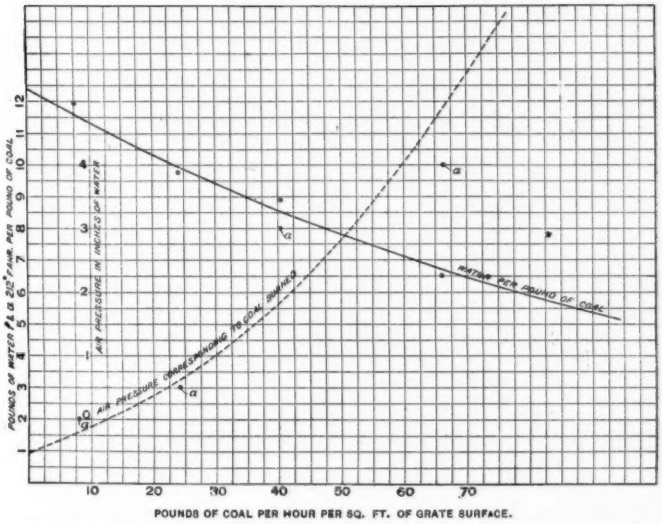

POUNDS OF WATER F & A AT 212° FAHR. PER POUND OF COAL
AIR PRESSURE IN INCHES OF WATER
AIR PRESSURE CORresponding TO EQUAL RATES
WATER PER POUND OF COAL
a
POUNDS OF COAL PER HOUR PER SQ. FT. OF GRATE SURFACE.

DIAGRAM SHOWING RELATION OF EVAPORATION, COMBUSTION, AND AIR PRESSURE FROM TESTS OF A THORNYCROFT BOILER ON U. S. S. CUSHING IN 1891.

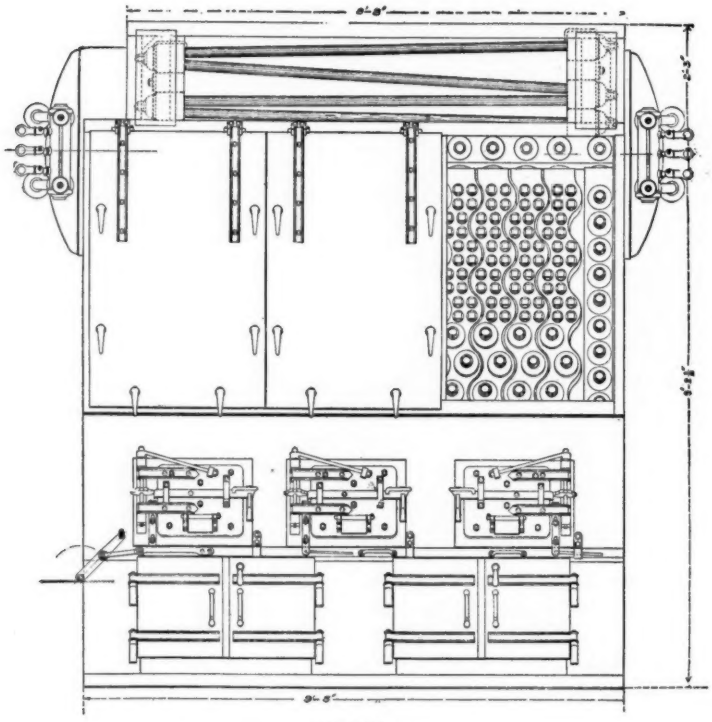
G.S., 38 sq. ft.; H.S., 2451 sq. ft.; H.S. ÷ G.S. = 64.5.

TABLE I. Tests of a Thornycroft boiler, with varying rates of combustion.

Air pressure, in inches of water	*0.00	0.5	3.0	4.0
Steam pressure, per gage, lbs	250	250	250	250
Coal per hour per sq. ft. of grate surface lbs	7.58	24.12	40.23	66.32
Actual evaporation f. & a. 212° Fahr. per lb. of coal	11.90	9.72	8.84	6.51
" " " " per sq. ft. of heating surface	1.40	3.63	5.51	6.70
Horse power per 100 sq. ft. of heating surface, on basis of 20 lbs. of steam per hour per I. H. P. f. & a. 212° Fahr.	7.00	18.15	27.55	33.50
Horse power per ton of boiler and water on same basis	15.6	40.44	61.38	74.65

* Blowers discharging into open fire-room.

The water-tube boiler is sometimes spoken of as "the boiler of the future," which might lead many to suppose that the type is very new, but such is not the case. Even in modern form, they have been in use on land for more than forty years, and the patents for some of those of the marine type are at least forty years old. Their

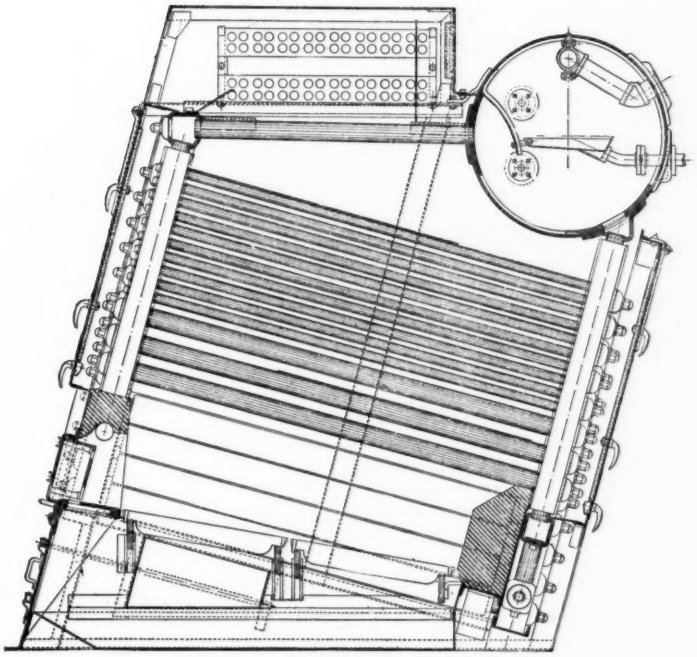


FRONT VIEW.

THE BABCOCK & WILCOX WATER-TUBE BOILER.

extended use, however, has occurred only in the last ten years. After discussing their advantages and disadvantages,—for they are not perfect,—we may consider the reasons which have prevented their more rapid introduction in the past, and those which now make it almost imperative to use them.

Water-tube boilers consist essentially of numerous tubes, of relatively small diameter, which constitute the heating surface, connecting one or more steam drums to one or more water drums, the water being on the interior of this system; while the exterior is surrounded by the hot gases of combustion which are contained in an envelope, which latter may be entirely of sheet iron and fire-brick or other non-conductor, or a row of contiguous water tubes inside of such a casing. We see at once the main reason for the reduction of weight in the dis-



SIDE VIEW.

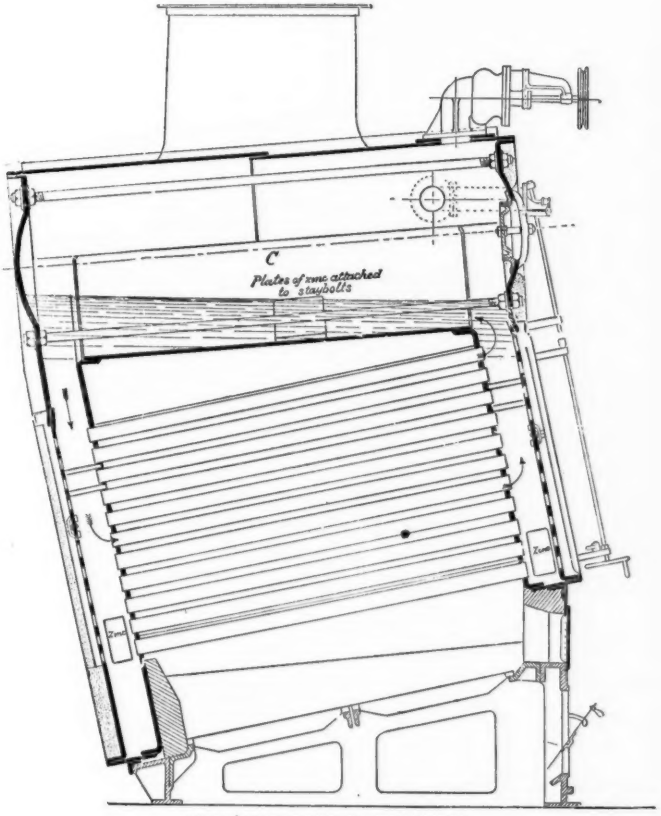
THE BABCOCK & WILCOX WATER-TUBE BOILER.

appearance of all the enormous plates of the shell and heads of the cylindrical boiler. In the water-tube boiler the plates are usually parts of small cylinders, and are thinner than the thinnest plates of the older type. The reduction of weight of contained water is even greater proportionally. Table II. gives the data of size, weight, and performance of a number of boilers of both types, with and without forced draft, and for merchant and naval vessels. The heating surface is the real measure of the power of a boiler, and the weight per square foot of heating surface therefore gives a good basis of comparison where the rates of combustion are the same. The other lines of the table enable account to be taken of varying rates of combustion, and it is to be noted that it is not unfair to the cylindrical boiler to compare such a case as the Ward boiler, burning 55 pounds of coal per square foot of grate, with that of the Newark, burning 40 pounds, as it is an indication of one of the advantages of the water-tube boiler, —ability to stand harder forcing without injury.

TABLE II. PERFORMANCE OF VARIOUS MARINE WATER-TUBE AND CYLINDRICAL BOILERS.

Kind of Boiler	Water Tube.				W. T.	W. T.		W. T.	W. T.	Cylin.	Cylin.	Cylin.	W. T.	Cylin.	W. T.
Maker or Style	Thornycroft.				Ward	Belleville		B. & W.	B. & W.	Dbl. End	Sing. End	Sing. End	B. & W.	Gunboat	Normand
Name of Vessel	U. S. S. Cushing.				Shore	Shore		Zenith Cty	Shore.	Newark.	Iona.	Wheeling	Marietta	Concord	Proposed
Outside Dimensions	10′ × 7′ × 8				10′. 3″ d 11′. 8″ h	11′ 6″ × 8′ 9″ × 17′		14′ 8″ 12′ 2″ 8′ 8″	15′ 7″ 10′ 6″ 8′	13′ 6″d 19′ 5″ l	13′ 3″d 10′ 0″ l	10′ 6″d 10′ 6″ l	11′ 7″ 11′ 7″ 11′ 5½	9′ 9″d 17′ 9″ l	10′ 12′ 4″ 18′ 7″
Grate Surf sq. ft.	38				53	91.4		67	38.5	135	21	30	47	55	95
Heating " "	2451				2473.5	2900		3400	1552	4185	1580	1254	1832	2052	4650
H. S. + G. S.	64.5				46.67	31.73		50.7	40.31	30.99	75.2	41.81	38.98	37.31	48.95
Wt. of Boiler, Empty, Tons.	9				11.84	36.00		31.85	17.78	57.80	29.30	25.91	23.24	30.19	36.87
" " Water "	2				2.01	2.00		7.41	4.21	22.32	17.87	10.94	4.02	14.99	9.12
" " Boiler and Water "	11				13.85	38.00		39.26	21.99	80.12	47.17	36.85	27.26	45.18	46.00
Duration of Trial, Hrs.	2.5	11.5	11.5	1.0	12	....	....	10	24	8	16	4	4	4	24
Air Press. Ins. of Water	0.0	0.5	3.0	4.0	2.0	a 6.3	a 8.0	nat. draft	0.9	2.25	0.2	0.78	0.36	2.3	.....
Feed Temp. F°	52	58.5	58	52	50.04	42	42	118	58.5	.....	106	104	121	140	.....
Steam Press. ab. atmos. lbs.	250	250	250	250	160	260	260	195	156.3	125.5	165	182	174	164.3	220
Coal pr. hr. pr. sq. ft. G. S.	7.58	24.12	40.23	66.32	55.05	18	24	26.6	44.2	40	22.4	30.92	24.47	42.74	27.2
Refuse %	6.11	8.04	7.53	6.27	4.84	11.5	5.4	8.8	7.0	3.3	2.9	4.0	4.0	3.7	.....
Moisture %	8.09	2.11	3.89	6.68	12.48	....	....	0.3	2.0	.....	2.87	.....	.....	.....	.....
Evaporation per lb. Coal:															
App f temp feed a temp st'm	10.55	8.13	7.53	5.69	6.60	8.78	8.47	7.01	7.01	.....	9.15	c 8.62	c 7.25	c 5.80	.....
" f and a 212° F.	12.95	9.93	9.19	6.98	8.04	10.81	10.42	8.06	8.47	.....	10.63	c 10.00	c 8.26	c 6.51	.....
Actual f and a 212° F.	11.90	9.72	8.84	6.51	7.31	10.81	10.42	8.04	8.31	.....	10.20	c 10.00	c 8.26	c 6.51	10.00
" " " 212° p sq. ft. Heating Surface	1.40	3.63	5.51	6.70	8.62	4.99	6.41	4.21	9.11	.....	3.08	c 7.40	c 5.19	c 7.46	5.56
HP. p. 100 sq. ft. H. S. f & a 212° @ 18 lbs. st'm pr I HP	7.78	20.17	30.61	37.22	47.89	27.72	35.61	23.39	50.62	b 55.90	17.11	b 43.05	b 28.76	b 41.47	30.91
H. P. p. ton of boiler and water on same basis	17.33	44.93	68.20	82.95	85.53	21.15	27.18	20.26	35.73	b 29.20	5.73	b 14.65	b 19.33	b 18.84	31.25
Wt. boiler and water p. sq. of H. S. lbs.	10.05				12.55	29.35		25.57	31.7	42.88	66.88	65.82	33.33	49.31	22.16

a. Natural draft, air mixer. b. Actual trial trip. c. Estimate from coal per I. H. P. at 18 lbs. steam per I. H. P.



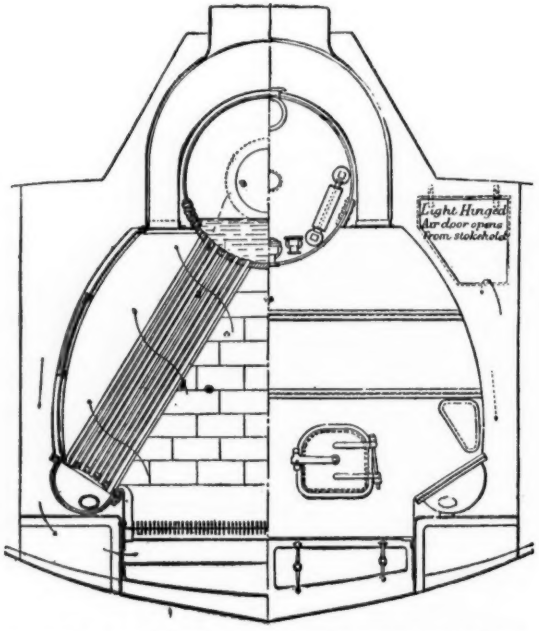
THE D'ALLEST WATER-TUBE BOILER.

Explosions less disastrous.—Of course, explosions are to be avoided entirely, but they do occur, and the small amount of water in the water-tube boiler assures a minimum of disaster. In 1895, while in the harbor of Kiel, a Ward launch boiler belonging to the U. S. S. San Francisco blew off the top of the steam dome. Nobody was hurt, and little damage done beyond the loss of the dome top, attached fittings, and boat awning. A new top was fitted at the Kiel dock yard, and the boiler afterwards did good service with forced draft.

Shortly before this, a locomotive boiler in a torpedo boat built for Turkey had exploded in the harbor of Kiel, because of the collapse of

a furnace crown, killing every man in and near the fire-room, and wrecking the boiler and the deck over it. The circumstances were, of course, different, one boiler being in an open boat and the other in a closed fire-room.

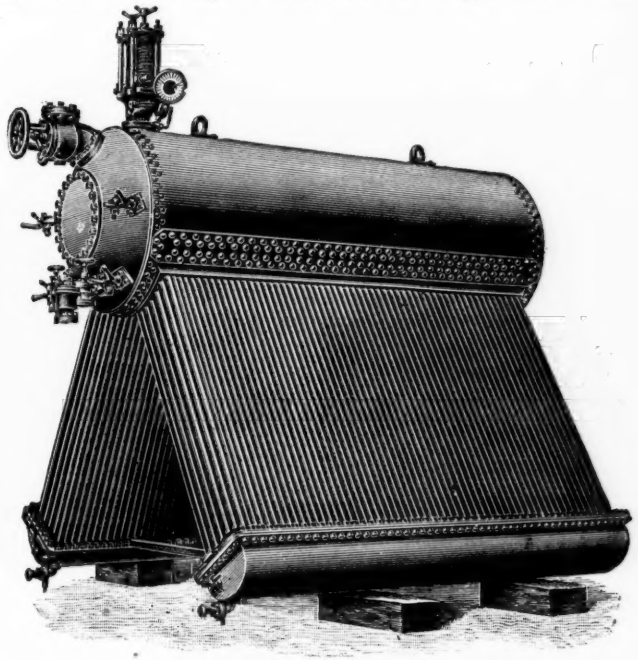
A recent case, described in *Engineering*, shows, however, that a



ELEVATION AND SECTION OF THE YARROW WATER-TUBE BOILER.

small shell boiler, when it explodes, will do great damage. The account says: " * * * when a fearful explosion occurred, accompanied by a deafening report. Pieces of the vessel were blown in all directions, and Mr. Tyrrell and his son were lifted to a considerable height in the air and thrown into the middle of the river. The launch itself disappeared, and all that remained were floating pieces of the wreck. The boiler was thrown against a wall on the river bank, and pieces of wood and iron were hurled in all directions, while some wooden gates on the opposite bank were set on fire by the hot coal from the furnace." The boiler was 3 feet 6 inches long and about 2 feet 2 inches in diameter.

A very recent illustration of the less danger from the explosion of a water-tube boiler is that of the boiler of one of the steam launches of the U. S. S. Texas in October of this year. The entire steam dome was blown off. There were nearly forty people in the boat, some around the boiler. Several received slight injuries, and one was slightly scalded. Except for the loss of the awning, the boat was not



THE YARROW WATER-TUBE BOILER.

damaged. Had it been a shell boiler, undoubtedly a number would have been killed.

The greatest loss of life from a water-tube-boiler accident was on the Jauréguiberry of the French navy, where a split tube caused a rush of steam and flame from the furnace fronts, resulting in the death of six men. There was, however, no wreckage, and the replacing of the defective tube and some overheated ones made the boiler as good as ever.

Ability to stand very high pressures.—This is evident from the design of the boiler, the greater part consisting of small tubes which can

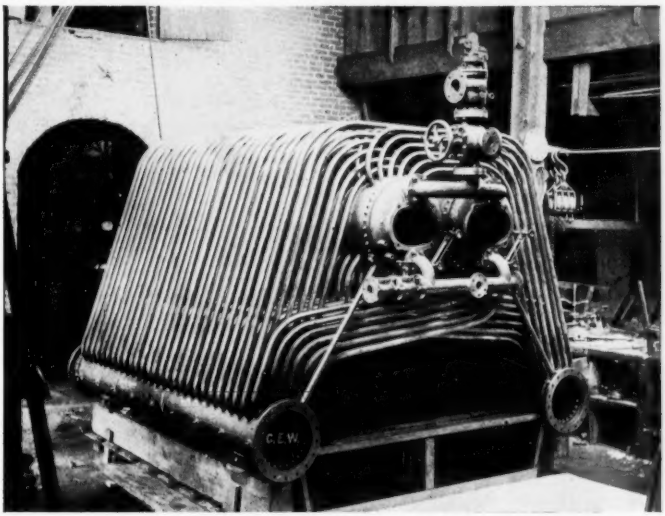
THE WARD WATER-TUBE BOILER.

As used on U. S. Coast-Defense Vessel "Monterey," U. S. Revenue Cutters "Manhattan," "Hudson," "Calumet," etc.

readily be made strong enough to carry pressures far above anything thus far thought of. Even in boilers with flat water legs, adequate strength is readily secured. The boilers of the torpedo boat Cushing have been carrying 250 pounds since 1890, and nearly all of the United States torpedo boats are designed for that pressure. The Nashville, designed in 1893 (a gunboat of about 1,400 tons), also carries a pressure of 250 pounds in her Yarrow boilers.

Sir John Durston, the eminent engineer-in-chief of the British navy, who has successfully fought so hard a fight in the introduction of water-tube boilers in that navy, is using even higher pressures, having adopted 300 pounds for the boilers of the Pelorus, which had her trials about a year ago. The boilers are the design of M. J. A. Normand, the famous French engineer and torpedo-boat builder. A sister ship, the Proserpine, has Thornycroft boilers for the same pressure.

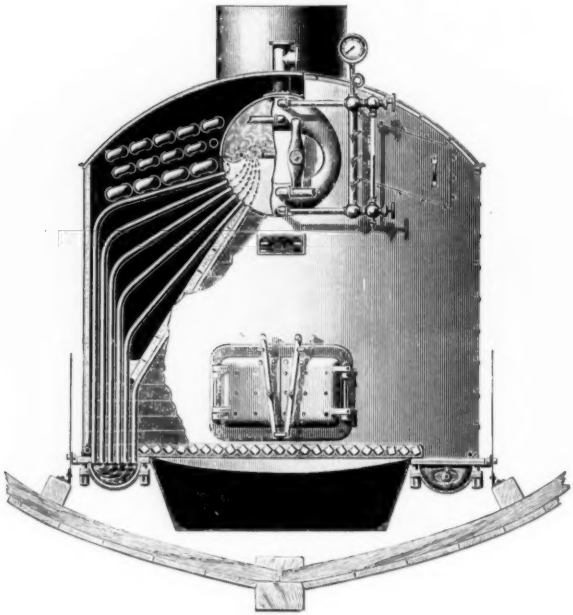
Ability to stand hard forcing and rapid change of temperature.—Speaking generally, this is true to a great extent of all forms of water-



THE WARD TORPEDO-BOAT BOILER.

tube boilers, and without limitation of those with small tubes. It is due almost entirely to the elastic structure of the water-tube boiler, which can accommodate itself to very high temperatures and to rapid changes of temperature. Just here it may be observed that, by general consent, there are two well-marked classes of water-tube boilers,—those with large and those with small tubes, the former being never less than four inches and the latter never more than two inches in diameter. This causes a marked distinction in detail. As the small tubes can be readily bent, they generally are, thus providing admirably for irregular expansion, and the facility of manufacture permits joining of cylindrical drums,—a very strong form. As it is practically impossible to bend the large tubes, they are always straight, and usually join flat water chests. The Belleville boiler secures a certain

amount of flexibility by joining the tubes in a zigzag by means of return bends, but this has its disadvantages. In both forms, however, the flexibility is much greater than that of the very rigid cylindrical boiler, so that they can stand almost any amount of forcing without injury. Mr. C. D. Mosher, the well-known builder of the fast boats



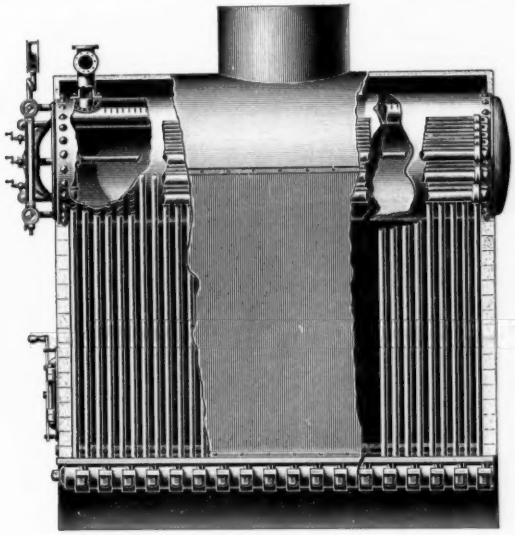
FRONT VIEW.

THE SEABURY WATER-TUBE BOILER.

Norwood and Feiseen, gave an account at the International Engineering Congress (Chicago, 1893) of a test of one of his boilers with an air pressure of 12 inches of water, and an evaporation of more than 18 pounds of water per square foot of heating surface, which was accomplished without injuring the boiler. American naval steam launch boilers (which are all of the water-tube type) show how this type can stand rough "heat usage." The service they perform is very trying and irregular, but does not result in the leaks which would be sure to come from such treatment in a shell boiler.

Rapidity of raising steam.—While not of much importance in merchant vessels, this is a point of great tactical advantage in war vessels. In time of war the ability to raise steam quickly is of vital

moment. It is possible in water-tube boilers both on account of the small weight of water and structure and of the freedom from injury due to rapid changes of temperature. This, too, is true only in part for the large-tube boilers, but entirely so for those with small tubes. It is perfectly practicable in one of the latter to raise steam from cold



SIDE VIEW.
THE SEABURY WATER-TUBE BOILER.

water in half an hour or less, while the large cylindrical boilers, when well cared for, are allowed from six to twelve hours.

Facility of repair and renewal.—The principal repairs to a water-tube boiler are to the tubes themselves, when they become defective through corrosion. At first they are usually simply plugged, as the heating surface is generally so extensive that the laying off of a few tubes does not matter. When corrosion becomes general all the tubes are renewed; this is ordinarily not difficult, and can be done by the force on board ship, as was the case recently on the Monterey of the United States navy. If it becomes a question of renewing the whole boiler-plant, the water-tube type has great advantages, as the largest parts, the steam drums, are still small enough to pass through existing openings. On a war vessel, with a protective deck, this is an important item. The installation of a cylindrical boiler 15 feet in diameter and 20 feet long requires the removal of a part of the deck.

This list of advantages almost makes it appear that any one who does not promptly adopt the new type is unprogressive. There are, however, some disadvantages, which have caused conservative engineers to be a little slow in accepting water-tube boilers as a commercial success. They are, perhaps, ready to admit their superiority for war

THE ALMY WATER-TUBE BOILER.

vessels and yachts, where the circumstances are peculiarly exacting, but they regard the shell boiler as an "old friend" not to be lightly abandoned.

First of all, the water-tube boiler does not lend itself readily to large power in a single boiler. There are probably hundreds of cylindrical boilers of 2,500 i. h. p. in use to-day, while there are very few water-tube boilers of 1,000 i. h. p., the vast majority having about 500. The Campania has twelve boilers for about 31,000 i. h. p., while the

THE REED WATER-TUBE BOILER.
As used on the British Torpedo-Boat Destroyer "Janus."

Powerful and Terrible each have forty-eight Belleville boilers for about 25,000 i. h. p. This great increase in the number of boilers means a proportionate increase in all fittings, with increased care in attendance. Col. Soliani, of the Italian naval engineers, very wittily expressed this at the Chicago Engineering Congress by saying: "It is easier to drive four big horses than twenty ponies."

The small amount of contained water, which is a great advantage in most respects, is a disadvantage as regards feeding the boilers and maintaining a steady steam pressure. Most builders of water-tube boilers now fit automatic feeding arrangements. Indeed, without them water-tending sometimes becomes, as was expressed by a friend of the writer who made a trip on one of our merchant steamers with a large battery of water-tube boilers, "a sprinting match." Passed Assistant Engineer Gage, U. S. N., in speaking of his experience on

the Monterey, said: "There is no trouble in feeding a lot of water-tube boilers in battery, but every chump who calls himself a water tender can't do it."

One serious disadvantage is that a bad leak in a single tube necessitates the disuse of the boiler, as steam must be blown off and the boiler cooled enough to permit entrance and access to the tube ends for plugging. This makes it advisable to have the unit for water tube boilers small, and this, as we have seen, is compelled anyhow by structural reasons. In a fire-tube boiler, a leaky tube can be plugged without any change in the regimen of the boiler.

It is probable that a better quality of tubes is required for the new type. The accident on the Jauréguiberry was due to a defective lap; makers certainly prefer weldless tubes. For the small thin tubes of torpedo-boat boilers they are absolutely essential.

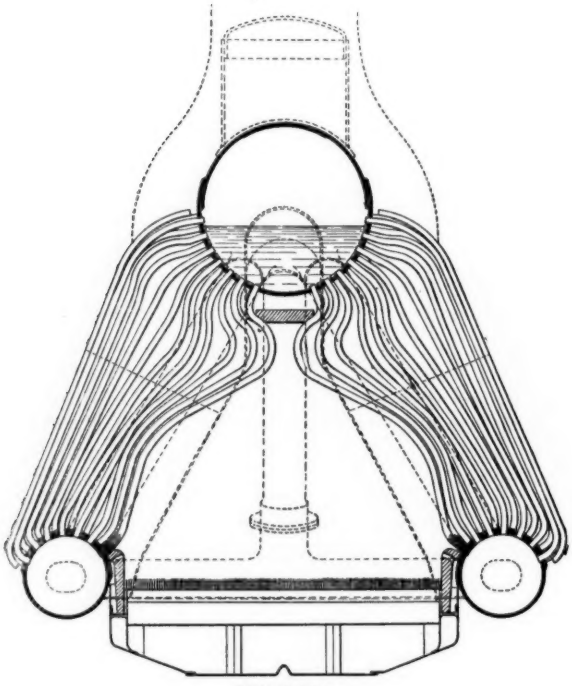
Many engineers believe, too, that water-tube boilers are not economical in evaporation. It is an undoubted fact that in a number of cases the uptake and chimney temperatures have been excessive, and the coal per i. h. p. (with economical engines) high. However, the figures in Table I. show excellent economy at all but the highest rate of combustion, as do those for the B. & W. Boiler in Table II., and it is safe to say that no ordinary cylindrical boiler would do any better, if as well. It must be remembered that, for high rates of combustion, Serve tubes and retarders have been fitted in the ordinary boiler. The writer believes this lack of economy, where it exists, to be due to two causes,—excessive forcing and too free a passage for the gases of combustion to the chimney. There has not yet been enough experience with all forms of water-tube boilers to enable their designers to secure the highest economy under severe forcing. Some of them are striving earnestly by systematic experiments to get this experience, but meanwhile the water-tube boiler is blamed because it does not do more than should be expected. Last summer the writer had the pleasure of visiting the works of Mr. Yarrow, known to all engineers as one of the most talented leaders of the profession, and whose famous experiments on circulation in water-tube boilers ended a long controversy, leaving the participants nothing to do but find an explanation. Notwithstanding the success of his boiler, he was still experimenting to secure economical evaporation at high rates of combustion, and had obtained very promising results. Yet some of his boilers, installed in this country, away from his own supervision, have not proved economical under severe forcing. This is not the fault of the boiler, but of the "baffling" devices for regulating the flow of the gases. Another case, where B. & W. boilers are concerned, has attracted a great deal of attention, but

the lack of economy is undoubtedly due to excessive forcing, as it has transpired that boilers designed for less than 7,000 i. h. p. were forced nearly 2,000 i. h. p. beyond the design. This question of economy is not a matter inherent in the type of boiler, but is a detail of design which will undoubtedly be satisfactorily worked out as further experience is acquired.

Longevity, or durability in regular working, is the point that has probably caused more hesitation in the adoption of water-tube boilers than any other. The tubes of cylindrical boilers corrode, too, but, after all, they are only a part of the boiler, while in the new type they practically are the whole boiler. Moreover, as already shown, the occurrence of a few bad leaks in different boilers simultaneously might throw out of use a large part of the plant. In the United States navy the rapid corrosion of thin steel tubes in ordinary boilers had made it seem probable that the life of a water-tube boiler would not be more than three years, but investigation developed the fact that the integrity and efficiency of the boilers had been sacrificed to the smart appearance of the ship, the boilers being used as trimming tanks, in defiance of all experience and the laws of chemistry. This has been stopped, and the boiler tubes are now longer-lived. Corrosion, after all, is very largely a question of intelligent care, and, if tubes of good material and reasonable thickness are properly cared for, their longevity will be satisfactory. Twenty years ago we did not know how to preserve boilers, but ruined them in the belief that we were pursuing a correct course. We are better informed now, and do not make such mistakes.

In tubes of small diameter, especially those that are bent, it is difficult, if not impossible, to clean the interiors properly, so that the use of salt water and the presence of oil are inadmissible. However, good practice also taboos these for cylindrical boilers. It may be said, and with reason, that salt water will sometimes be unavoidable from a leaky condenser. Mr. Yarrow, with his usual sagacity, recognized this, and, in his usual way, put it to the test of experiment. He went much further than a simple leak, and practically fed from the sea, until the density was nearly five times that of ordinary sea water. The result, after an eight-hour run, was a very light coating of scale in places, which was easily removed. The test was repeated a number of times with the same result, showing that a slight leak in the condenser need cause no fear.

Space will not permit an extended historical notice of the water-tube boiler for marine purposes. It appears that it was used as far back as 1857, but the early efforts failed for various reasons. Mr. Charles Ward, the designer and builder of the water-tube boilers of

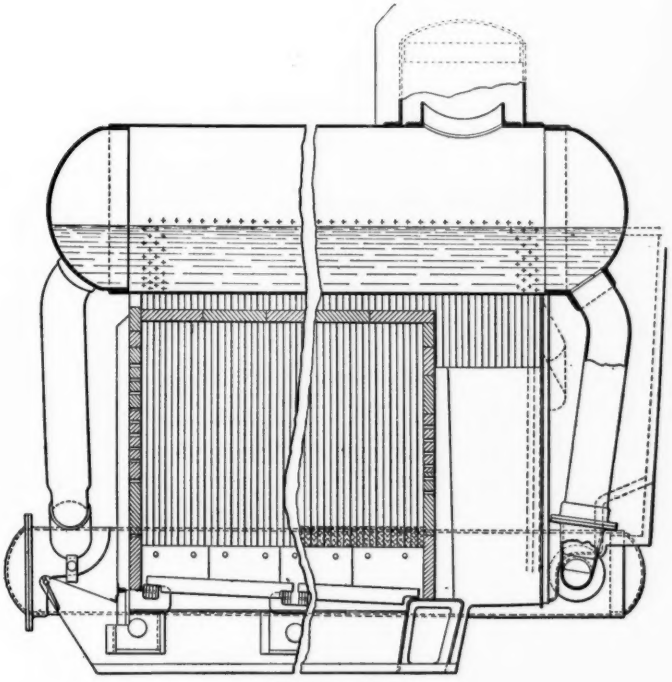


THE NORMAND WATER-TUBE BOILER.

As used on the French Torpedo-Boat "Forban," and on H. M. Torpedo-Boat Destroyers, "Surly," "Shark," "Rocket," etc.

the Monterey and of most of the steam launch boilers in the United States navy, places the renaissance of the water-tube boiler for ships about twenty years ago, when Herreshoff, Loftus Perkins, Thornycroft, Belleville, and himself were all working at the problem. The Voltigeur, of the French navy, had Belleville boilers installed in 1879, and they were gradually placed in other vessels. Other types were also tried, and now cylindrical boilers are no longer used in new designs. For some time only large-tube boilers were used in large ships, but the triple-screw cruiser Jeanne d' Arc, of 11,000 tons and 28,000 i. h. p., is to have Normand (small-tube) boilers.

The use of water-tube boilers in torpedo boats began when Mr. Thornycroft, another talented engineer, built the Ariete for the



LONGITUDINAL SECTION.
THE NORMAND WATER-TUBE BOILER.

As used on the French Torpedo-Boat "Forban," and on H. M. Torpedo-Boat Destroyers, "Surly," "Shark," "Rocket," etc.

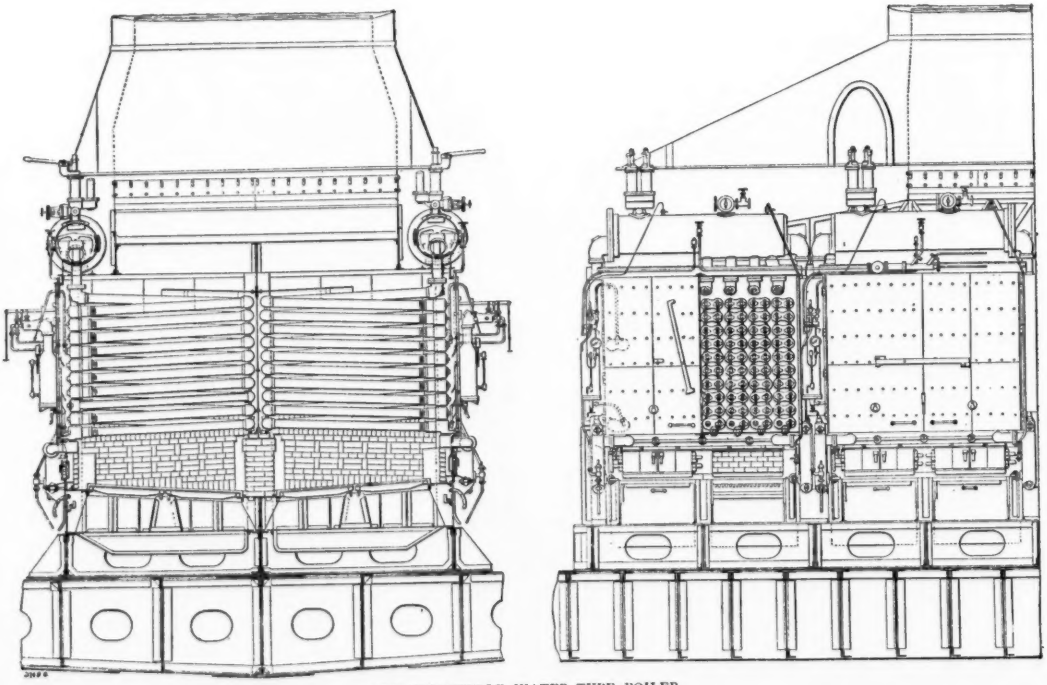
Spanish navy in 1887. In the intervening ten years the small-tube form of the new type has taken possession of the field, although a few designers who had made a great success of the marine locomotive boiler clung to it desperately, and one, as late as December, 1892, attempted to show that it was as light and efficient as the water-tube. In the United States navy, although it has had only a few vessels of this class until now, they have all had water-tube boilers, beginning with the Herreshoff boats Lightning and Stiletto, the latter being afterward provided with an Almy boiler.

The British navy promptly took hold of the small-tube boilers for torpedo boats, and in 1893 eight Thornycroft boilers were fitted in the Speedy, a gunboat of about 800 tons. In that year also, Belleville boilers were ordered for the Sharpshooter, which has since served

as a training-school for stokers and as an experimental ship for Belleville boilers. Sir John Durston had made up his mind to use water-tube boilers, but he had a hard fight, and it is safe to say that he staked his professional reputation on the success of the Belleville boilers of the Powerful and Terrible. He had sent officers to make long trips on merchant steamers fitted with these boilers, had tried them in the Sharpshooter, and was satisfied they would be successful. Many able engineers do not share his opinion that this is the best of the water-tube boilers; indeed, many regard it as ranking low, but Sir John probably had in his mind that the great argument against water-tube boilers would be that they had not been in use long enough to warrant their adoption. To this objection only the Belleville boiler could answer, as it had been in use in the steamers of the Messageries Maritimes since about 1885, and has been fitted in each new steamer they have built. Consequently he could make a better fight for this boiler than any other. Although beginning the use of water-tube boilers on the large ships so recently (the Powerful and Terrible were tried only about a year ago), the British navy has adopted them entirely, and all the new vessels now building are to be supplied with them.

In the United States navy the present engineer-in-chief, Commodore Melville, with characteristic energy, took up this subject as soon as he was appointed in 1887, and in a very short time all the steam launches were fitted with water-tube boilers. A few had had Herreshoff boilers of the old type, which had not given entire satisfaction, although possessing some good features. (It may be mentioned, in passing, that the United States navy is the only one which uses water-tube boilers exclusively for steam launches.) In 1888 he induced the navy department to invite a competitive test among makers of water-tube boilers in the United States, with a view to their use in naval vessels. The tests took place in 1889 and 1890, and, as a result, four Ward boilers of an aggregate i. h. p. of about 4,500 were ordered for the Monterey. The vessel was tried in January, 1893, and has been in commission ever since, the boilers giving entire satisfaction. This was the first instance of as great a power as this in water-tube boilers in a large vessel. Since then Babcock & Wilcox boilers have been fitted in the Marietta and the Annapolis, and Yarrow boilers in the Nashville. B. & W. boilers are building for the Chicago and the Atlanta.

It is perhaps, at a hasty glance, a source of surprise that, having started the use of water-tube boilers on large ships nearly ten years ago, Commodore Melville should not have pushed their introduction as new ships have been designed. His position has been rather



THE BELLEVILLE WATER-TUBE BOILER.

As used on the Russian Volunteer Steamer "Kherson," also on the British Cruisers "Powerful" and "Terrible," etc., etc.

embarrassing. Convinced personally of the success and reliability of the water-tube boiler, and realizing the *éclat* he could so easily gain by being thoroughly "progressive," he yet felt that he would be risking too much for the new fleet in filling it with boilers about whose durability there might be a question. The Monterey is a coast-defence vessel, and would always be within easy reach of repair shops, so that, had there been trouble with her boilers, it could have been quickly remedied. One object in fitting water-tube boilers in her was to test, by practical use on a large vessel in regular cruising, their durability and general qualities. To reduce weight is a good thing, but to have thoroughly reliable boilers is better, and the saving of some tons of weight would have been dearly bought if it involved the laying up of a battle-ship when the nation had only three afloat. The two great powers which have made the change were simply adding to already powerful fleets; the United States were creating theirs from nothing. Now that they have a respectable fleet, and experience has been gained with water-tube boilers that insures their reliability, Commodore Melville has decided to use them entirely, as shown by his last annual report, recently published.

In the merchant marine, water-tube boilers have not been used to anything like the extent they have in navies; indeed, it is not much of an exaggeration to say that they are hardly used at all in the merchant service, except in France and the United States. Russia has at least one example in the Kherson, of about 13,000 i. h. p., and there are a few English vessels of small powers. It is exceedingly difficult to give figures for the aggregate horse power of the water-tube boilers in the merchant service of different countries (including yachts) without an amount of research entirely disproportionate to the result sought, but round numbers about as follows are probably not greatly wrong: France, 80,000 i. h. p.; United States, 140,000 i. h. p. There are three United States vessels having more than 7,000 i. h. p. each of water-tube boilers.

Boilers of this type have been in use in the United States since 1878, and a number of boilers have lived more than twelve years, some of them in sea-going vessels.

The delay in introducing water-tube boilers in the merchant service, as compared with their naval use, is exactly the reverse of the experience with multiple-expansion engines. In the latter case the merchant service was in the lead by several years. The reason for the difference is probably largely due to the different requirements of the two services. In the naval vessels, anything that will reduce weight is eagerly welcomed, regardless (within reason) of economy. In the merchant steamer, economy is the first consideration, almost

regardless of weight. Consequently, as the chief advantage claimed for water-tube boilers was reduction of weights, it did not appeal to the commercial world as it did to the naval designer. Again, nearly all navies had had trouble with shell boilers, due to excessive forcing in the effort to keep down weights, and the water-tube boiler gave relief from this evil. The boilers of merchant steamers were never forced very hard; so this advantage of the new type was not so attractive for them. There is little doubt, too, that the great majority of builders of boilers for merchant steamers have felt that the shell boiler, when properly managed and cared for, was entirely satisfactory, and that there was no special object in using a type of boiler which has its disadvantages, and which would render useless a valuable portion of their plant.

As yet, there is certainly no agreement on any existing water-tube boiler as the best. Nearly every designer of ability thinks he can improve on what he considers the best existing boiler, with the result of very numerous patents. Where so many eminent men disagree, it would be unbecoming in lesser lights to indulge in prediction, but the writer believes it worth while to call attention to one aspect of the case. If the full benefit of water-tube boilers is to be obtained, it seems almost certain that they must be of the small-tube variety. As already shown, they possess all the merits of the new type (which is not true of the large-tube boilers), and the disadvantages are almost entirely such as are common to all boilers. Some years ago Chief Engineer Frank H. Bailey, U.S.N., one of the ablest American naval engineers, expressed the opinion that the "boiler of the future" would be of the small-tube variety, but with scantlings increased so as to insure longevity, increasing the weight per square foot of heating surface from 11 or 12 pounds, as in torpedo boats, to from 18 to 20 pounds. At the International Congress of Naval Architects and Marine Engineers in London, in July of this year, M. P. Sigaudy, the manager of the Forges et Chantiers de la Méditerranée at Havre, and the colleague of M. Normand in the Normand-Sigaudy boiler, read a paper giving designs for boilers of 23,000 i. h. p. for a transatlantic express steamer, in which he takes the view previously expressed by Chief Engineer Bailey. The last column of Table II gives some data of one of the boilers he proposes to use.

Finally, the prospect is that, in time, the water-tube boiler will be practically the only one used on shipboard. Even in the merchant service, weight is too valuable to be needlessly sacrificed. Evolution does not work backwards. Admitting that there are defects in the water-tube boiler, experience and intelligence will remedy them, as they have always perfected whatever was correct in principle.

THE TALL BUILDING FROM AN AMERICAN POINT OF VIEW.

A REJOINDER TO S. H. CAPPER.

By A. D. F. Hamlin.

THE wise man welcomes new views of matters which he has been accustomed to consider chiefly from a single standpoint. It is a good thing sometimes to be withdrawn from our environment and compelled to face the problems of our time from a different point of view,—to see ourselves and our doings, indeed, as others see us and them. This is as true of our American architecture as of any other interest; the changing conditions of a rapidly-maturing civilization create new problems every year, for whose solution we need all the light and wisdom that we can get. We are trying to solve these problems according to our lights; not always well, not always wisely, but in our own way, unhampered by tradition, and unassisted by example. It is a salutary thing to have the results reviewed from the European point of view. For, although the European can not be expected to enter fully into our situation, he can for that very reason the better point out failings of which we are only half conscious, or to which we have been wholly blind, and give us encouragement where we may have failed to appreciate our real successes. Cases of the latter sort are few, I fancy.

Prof. Capper, in his interesting paper in the November issue of this magazine, gives us the impressions of a cultivated English architect on the architecture of our tall buildings, particularly those of New York. Whatever may be thought by American critics, it is evident that to the European the American "sky-scraper" represents a most important contribution to architecture, and that our struggles with that intractable problem have attracted more attention in Europe than anything else we have done. This is not surprising, for our "sky-scrapers" are exceedingly *voyants* affairs, and exceedingly American. I question whether American architects generally look upon them in the same way; but otherwise the American point of view appears to be substantially identical with that presented by Prof. Capper. Leaving aside a few minor criticisms and opinions, the main body of his paper expresses very fairly considerations and conditions which our own architects have more or less clearly recognized and struggled with, ever since the tall building began to rear its self-asserting and ungainly form in our cities. In presenting the

American points of view, therefore, I seek to blow no counterblast to Prof. Capper's critique, but rather to endorse and expand much that he has said briefly and concisely.

In the tall building it is emphatically "a condition, not a theory," that confronts us. The many-storied office-building is a necessary product of certain economic factors which have operated in spite of the architects, and more intensely in the United States than elsewhere. This is what has made it so peculiarly an American product. Of these economic factors the cost of land, so commonly alleged as the controlling one, has really been the least important. Land in parts of Paris and London is as costly as in New York and Chicago, but the fifteen-story office-building has never come into vogue there, while, on the other hand, buildings of ten or twelve stories are not uncommon in American cities of the second and third rank, where land is relatively cheap. The *causa causans* of the sky-scraping monstrosity is to be sought in the drive and hurry of American business life, and in the accompanying American propensity to save time and labor. The "sky-scraper" is a huge labor-saving and time-saving device. Not only does it make possible the concentration within a small geographical area of an amount and variety of business which otherwise would be spread over five or six times the same extent of territory, but it gathers into a single edifice an extraordinary number of activities, which otherwise would be widely separated. Each building is almost a complete city, often comprising within its walls banks and insurance offices, post office and telegraph office, business exchanges, restaurants, club-rooms, and shops. The business man can provide himself with clothes, shoes, cigars, stationery, and baths; receive and dispatch his mail and his telegrams; speculate on 'change; consult his lawyer and his architect in their offices; and transact his own business,—all without leaving the building in which his office is located. The express elevator which shoots him up to the sixteenth story or drops him with breathless speed to the basement is a product of this same American haste and economy, and without the elevator the tall office building would be an impossibility. It is the triumphant success of the "sky-scraper" as a time-saving invention which has made it so conspicuous and insistent an element in our American architecture.

It is open to question whether the mere love of tallness has had much to do with the development of this convenient and necessary architectural nuisance. Increased height has, I imagine, usually been sought after, both in New York and Chicago, as a means for securing larger returns upon the capital invested in land, rather than to gratify the love for big things *per se*. Still, there is no reason to

deny that the desire to outdo has had a perceptible influence in developing the architecture of the "sky-scraper"; not the mere love of tallness, but the ambition to surpass in achievement. The Washington monument is not, I think, a pertinent matter in this discussion. It was conceived before the tall office-building had come into being, and it is not generally regarded as in any sense a work of architecture. But it certainly is in our blood to admire scale, vastness, bigness, even of mere dimension, and to seek to outdo in these qualities in much of what we undertake.

This propensity we may indulge to excess, but we have no monopoly of it. It is present in all great and enterprising peoples. It has been at the bottom of our extraordinary material advance in the past twenty-five or thirty years. But it has also inspired the great achievements of other nations and times. The White Star Line is now building a steamship to beat the Kaiser Wilhelm der Grösse, which was built to beat the Great Eastern, which was built thirty-eight years ago in England to be the biggest ship afloat. The present basilica of St. Peter at Rome was built to be the biggest church on earth, and was conceived in the first place by Pope Julius II to serve as a mausoleum for the biggest tomb on earth—a purpose which was never realized. Amiens cathedral was planned to be the biggest and "tallest" cathedral in France. Later the diocese of Beauvais tried to build a bigger one yet, with a taller vault. They came to grief, but the choir of Beauvais is still the tallest and broadest choir in France. Cologne cathedral was designed to be the biggest cathedral in northern Europe, and its twin spires to be the tallest and biggest. Prof. Capper himself cites the ancient Egyptians and the ambition of Queen Hatasu, or Hat-shep-sut, to erect the tallest obelisk: "they vied eagerly in the size of these noble blocks." The ambition to surpass in mere dimensions has given rise to some of the most impressive architectural monuments in the world. It is to be deprecated in works of art only when it is unaccompanied by artistic taste and judgment, as was the case with the Washington shaft. That this is not always the case with us I think the Columbian Exposition may be adduced to prove. As to the city hall at Philadelphia, most American architects prefer to change the subject when it it is mentioned. It is not quite fair to compare its tower with the spires of Cologne or Burgos or Strasburg. American architects have done some creditable work in tower-building. The spires of St. Patrick's cathedral in New York are not as tall as the Washington monument or the Philadelphia Penn-capped tower; but they are lofty, and they are beautiful. And there are others.

Mere height without art is not in itself admirable; certainly our

Anglo-Canadian friend is right in this. It is not the height of our office-buildings that we admire. Indeed, we may almost say that from the purely artistic point of view they do not satisfy us at all.

They are, it is true, admirable as works of engineering design and construction. American inventiveness and mechanical skill have achieved in them a genuine triumph. There is no class of modern structures, on the whole, better built, better equipped, better arranged, better furnished, than the great office-buildings of New York, Chicago, Boston, and Philadelphia. From the practical and utilitarian point of view they represent a very high degree of successful achievement. But to the eye of the architect they certainly do not appear as works of preëminent artistic merit. Some of the reasons for their failure as architectural compositions the article already referred to clearly recognizes. An immensely tall edifice, which has the proportions, in one direction at least, of a tower, but which cannot logically be treated as such; which must be perforated by almost countless small windows, and be divided into the greatest possible number of stories; whose ground story must consist of stores with huge plate-glass fronts, and upon whose flanks, abutting on party-walls, architectural projections of any sort are forbidden; a vast edifice without a single heavy pier, and in which effective contrasts of voids and solids are generally impossible; an edifice, moreover, in which practical and financial considerations must of necessity dominate, leaving to artistic invention the narrowest possible margin for its exercise,—such is the problem which American architects have had presented them for solution. That they have not yet succeeded in making of this intractable monstrosity a temple of beauty is not to be wondered at. Even Mother Nature, in framing the elephant, the whale, and the giraffe, has not produced the acme of grace and attractiveness, to human eyes at least, though these three colossal designs of hers are no doubt admirably adapted to their purpose and function from the practical point of view.

The practical and structural aspects of the problem have, as I have said, and as is generally conceded on both sides of the Atlantic, been handled by our architects with commendable skill and ingenuity. The engineering questions and difficulties in these buildings are so important that an entirely new and very interesting relationship has grown up between architecture and engineering. While it is true that the problems of deep foundations and of steel-frame construction have been chiefly worked out by professional civil engineers, it is equally true that these men have labored side by side with the architects, often in business partnership with them, and that each side of the partnership has profited greatly by association with the other, and

learned much from it. The engineers have become specialists in the architectural phase of their profession, while, on the other hand, the architects have been compelled to master at least the general principles of engineering construction. This intimate association of the two professions, so long distinct and almost hostile, is a fact of deep import and full of promise for American architecture. One glory of Gothic architecture is precisely that intimate union of scientific construction with artistic design which made of Amiens, for instance, so consummate a piece of engineering as well as so noble a work of pure architecture. In the Middle Ages structural problems were solved empirically; it took two hundred years to learn how to build an Amiens. Each builder solved a problem identical with that of his predecessors, but tried to do it better. Thus the amount of novel engineering calculation or study required for each new masterpiece, and the amount of novel artistic invention in the design, were alike reduced to a minimum. The work was carried on slowly and cautiously, with all the advantage of accumulated experience. With us, ten years have sufficed to create entirely new problems both of construction and design. Every year brings out new demands and new inventions. The engineering of a tall office-building is vastly more difficult and complex than that of any cathedral, and never repeats itself. The whole structure must be designed and built in eighteen months or two years. No "master builder" of the Middle Ages, no Abbot Suger, no William of Wykeham, would have sufficed for the task. It is the association of the engineering expert and artist-architect that has made even a tolerable solution possible. The interesting, the suggestive, the hopeful fact is that this has become no mere juxtaposition, but a really intimate and consentient partnership, and that, as a result, not merely in tall office-buildings in the United States, but in our American architecture generally, good planning and exterior design have become, and are becoming, more closely associated with first rate construction. In this we have in the past been wofully behind European practice; it is a question whether we have not now overtaken it. Any one who remembers how American buildings were commonly put together twenty years ago will recognize the improvement. The importance of this side of the profession Columbia recognizes, by offering to its fourth-year students in architecture an alternative course in architecural engineering, and by emphasizing the structural applications of mathematics, physics, and chemistry in the three preceding years of the course. If the tall office-building is to be considered as the chief contribution of American architects to their art, I believe its real importance lies in the considerations I have just advanced.

As for the artistic qualities of this contribution, it may be frankly admitted that we have by no means satisfactorily solved the problem of exterior design. Many difficulties, defects, and failures are plain to our consciousness, besides those so clearly pointed out by Prof. Capper. The suggestions he makes are interesting, and quite in the line with American experience. They have all been tried, though it is very likely that they have not all been rightly or sufficiently tried. With regard to two of them there is likely to be considerable difference of opinion. Whether it is or is not desirable to emphasize the vertical element instead of the horizontal cannot be settled by any off-hand and sweeping rule. The multiplied reiteration of the horizontal line in the St. Paul building, for instance, can hardly be regarded as a thoroughly successful treatment. To accord a certain amount of importance to the vertical elements in a lofty building certainly seems reasonable; to suppress them altogether in favor of accented horizontal lines is to make a vain effort to deny the undeniable fact of height. It renders ineffective the one impressive dimension of the building, and emphasizes with tiresome repetition the littleness of the component stories. Not so have those lofty towers and domes of Europe been designed. In all of these one notes a wise balance and combination of vertical and horizontal elements. The existence of stories is not dissembled or forgotten; but neither is there any effort to deny the elements of height.

It is very true that an office-building can rarely be treated like a tower. The breadth or depth of its flanks in most cases forbids this. Otherwise there is no valid reason against such treatment. If the ground plan is square or only slightly oblong, and the height four times the frontage or more, the building becomes *ipso facto*, a tower, —not, it is true, a campanile or spire, but none the less a tower. Why not treat it as such? In other words, why not distribute the voids and solids, reënforce the angles, proportion the horizontal divisions, and profile the crowning features, so far as possible, upon the principles which have produced satisfactory results in tower design? The difficulties in the way are practical, not theoretical; and the chief one is the necessity of sprinkling the whole body of the tower with peep-hole windows. All the more is it desirable, some will certainly argue, to mask and minimize this monotony of equal perforations by grouping them within strong architectural lines, mainly vertical, in order to give scale and dignity to the composition; and this is precisely what is sought in a tower, and what many of our architects have sought to do in their office-buildings.

This involves the second point in which the European view may raise discussion, the treatment of the openings. It is readily granted

that multiplied repetition of an architectural feature is one of the surest means to the end of impressiveness. The Colosseum is justly cited in support of this proposition; the long vistas of English cathedrals furnish another illustration. But the feature thus repeated must possess intrinsic dignity or artistic value; it must have *scale*. This is precisely what office windows do not and cannot possess. The office-floors average ten or eleven feet clear in height; window sashes more than four feet wide are awkward to handle. These are not heroic dimensions. The bays at the Colosseum average twenty feet on centers and thirty to forty feet in height; its four stories equal the height of an ordinary ten- or twelve-story office-building. The front of the Pitti Palace at Florence is most impressive with a vast number of windows all exactly alike, but they are colossal. The three stories of the palace are each nearly forty feet high. How to make two hundred to three hundred windows 4×8 feet each (or thereabout) into an impressive composition is really the *crux* of tall-office-building designing.

In Chicago, where so many of the structural difficulties of the problem were first worked out, the utilitarian requirements as to voids and solids have been most frankly accepted. There is, as a rule, less effort there than in New York to devise a distinctively architectural, or even artistic, frame for these countless openings. There is a certain boldness in this frank acceptance of conditions which is not without merit. And yet the result is not artistically pleasing, and the procedure can never lead to highly artistic success, because it is really a surrender to the difficulty, not a triumphing over it. Moreover, the Chicago examples have the advantage generally of greater breadth and mass than those in New York, among which there are but few that cover very large areas,—the Mills, Washington, and Bowling Green Buildings, and the Produce Exchange, among them.

That the New York examples, in which a more architectural membering of parts is sought after, are by no means ideally successful is admitted. Some of them err by too great insistence on vertical lines; some by a confusion of horizontal and vertical elements; some by a too complete negation of the vertical. But in the best among them certain principles appear to be gradually crystallizing into practice. The horizontal divisions are so managed as to give a distinct pedestal, shaft, and capital, or crown. The base, made as solid and vigorous as circumstances will permit, is adorned with details of great richness, to catch the eye of the passer on the street. The shaft is sometimes very plain, with uniform windows uniformly spaced; more often divided by strong piers or pilasters separating grouped windows, forming a species of colossal flutings. Usually the corners are treated like broad piers, pierced with as few windows as possible, to give strength

to the composition. At the top, two, three, or four stories, contained between a strong band or architrave below and a vigorous crowning cornice, are treated as a capital to the design, with great richness of architectural light and shade, the decorative features being moulded on a large scale to suit their great distance from the eye. In some cases, the skyline is diversified by turrets and steep roofs; more often a decorative *chéneau*, or balustrade, serves as a cresting above the cornice. The great difficulty in this aerial architecture is the question of scale; it cannot be treated so as to be equally satisfactory in its relation to the whole huge building and to its small component parts. And it is true that the problem of the crowning cornice has not yet received its final solution.

In matters of detail, internal and external, there is more to commend. Sculptors, decorators, mosaic workers, and architects have in many cases wrought in close and harmonious association to beautify those parts of these buildings which are most in view. I believe there are few, if any, cities where the fine arts, the decorative industrial arts, and the art of architecture are practised in closer alliance than in New York, or where the relations between their practitioners are more wholesome and agreeable. In time they may together work out a worthy solution even of the complex and stubborn problem of the tall office-building.

MODERN WHARF IMPROVEMENTS AND HARBOR FACILITIES.

By Foster Crowell.

III.—THE DEPENDENCE OF SHIPPING UPON GRAVING AND REPAIR DOCKS.

WHEN it had become absolutely necessary, recently, to dock the United States battle-ship "Indiana," for cleaning and painting, Uncle Sam was obliged to send her to Halifax, Nova Scotia, and make use of the British dry-dock there. We can imagine that, before taking this step, some traces of the moisture of mortification may have been visible in his near sighted, national eyes as he recalled the vigorous twists he had just been imparting to the lion's tail, and other twists yet to be given as soon as he could get his ship cleaned and safely home again. But it is also to be inferred that no actual tears were shed, and that he will go on borrowing such facilities until his naval engineers give him "sure enough" dry-docks, as Uncle Remus would say. In view of certain notorious developments regarding several of the more recent efforts of the navy in this direction, it would be cruel to dwell on the subject, and perhaps somewhat misleading, because some of the larger United States vessels have actually been docked at home; in fact, one of the illustrations of this paper shows the "Iowa" in dock at the Brooklyn navy yard.

Neither is it necessary to enlarge upon it, the whole story being contained in two lines; the navy builds dry-docks, but the "Indiana" had to go all the way to Halifax simply to be cleaned.

It will probably be said that there was nothing unusual in this; that it is customary for ships of war of all nations to avail themselves of the nearest suitable dock of a friendly power,—which is, of course, true; but that does not alter the fact that a nation which possesses no adequate facilities of its own for keeping its war vessels in constant condition for service is at a perpetual disadvantage, on economic grounds in time of peace, and in much graver respects whenever the navy is needed in dealing with foreign complications.

Since the above lines were written, a very high authority in naval matters, the Chief Constructor of the United States navy, Philip Hichborn, has called attention, in his annual report to the secretary of the navy, to the lack of docking facilities in the United States, making an urgent plea for more and better docks, pointing out that the navy has been at a serious inconvenience during the past six

U. S. S. INDIANA IN DRY-DOCK AT HALIFAX, N. S.

months for lack of proper facilities for docking battle-ships, and suggesting additional docks at Mare Island, Portsmouth, and Boston, and larger docks at Norfolk and League Island.

The disagreeable truth brought out so forcibly, in its purely military aspect, by the "Indiana" incident is just as repellent, if not as obvious, when considered in reference to the requirements of commerce. It is a rare event for an Atlantic liner to go into dry-dock on the western side of the ocean, for the reason that there are no suitable ac-

commodations for them, excepting at Newport News and Philadelphia, where are dry-docks, belonging to ship-builders, which can be availed of for repairs, although not for the largest vessels, but whose remoteness from New York harbor makes their use too inconvenient to be resorted to ordinarily. Besides, the owner of a vessel usually prefers to have it docked at the home port when possible.

The lack of docks, as has been stated, is a serious disadvantage to the United States, viewed from a purely economical stand-point and considering naval ships alone; the difference in attainable speed, with the same coal-consumption, depending upon the cleanness or foulness of a vessel's bottom, is enormous, amounting in observed cases to 30 to 50 per cent. In extreme cases even greater differences in speed-capacity may be looked for. If the question of speed becomes paramount at such times, it can be only partly met by increased coal-consumption; thus various elements of waste are augumented,—*viz.*, excess of coal consumed, excess of outlay for wages and subsistence of the ship's people in performing a given duty, excess of interest and maintenance charges, and loss of effectiveness of the ship. The aggregate of this excess of cost, applied to the hundred or more naval vessels in active service, cannot be computed, but, if it could be, it would doubtless be appalling. When we consider that the United States have many ships that have cost for construction from $1,000,000 to $4,000,000 each, and that a dry-dock of the largest size costs not more than $750,000 and is available for many ships for years, the national policy of not making full provision at every port which the naval ships can enter seems radically defective and un-economical.

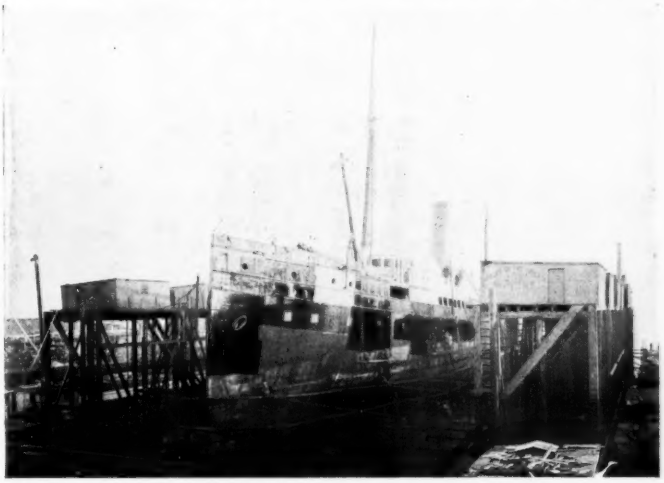
The nations of Europe show no such lack. Every maritime nation has a fine provision of graving docks and repair docks, generally in convenient juxtaposition to the commercial docks,—sometimes, indeed, a part of them. The graving docks for commerce may be quite distinct from those required for the naval establishment, though in certain ports a wise policy has been adopted of combining the two functions in one structure, and it seems very desirable that such a course should be followed by the United States government in its future provisions. For the non-technical reader a definition or two may here be needed. By a "graving dock" is meant any kind of a dock wherein a vessel may be artificially supported, and the water removed so as to permit of free access to her sides and bottom for the purposes of cleaning, painting, or repairs. According to the Century Dictionary, graving has two meanings, one being the act of laying in a grave, which the process of dry-docking suggests, and the other the operation itself of scraping and cleaning a ship's bottom.

A dry-dock is a basin established in solid ground, or at least

partly surrounded by *terra firma*, into which a vessel may be floated, and from which the water may be entirely removed after closing the entrance-gate. The water may be removed by pumping, or, where the rise and fall of the tide equals or exceeds the depth of flotation, it can be emptied and filled by gravity.

In certain situations dry-docks can conveniently be placed so that their normal water surface corresponds with the half-tide, thus largely increasing the number of docking hours.

A floating dock is, in effect, a submerged platform, or pontoon, upon which is erected a cradle or other device to receive the ship's hull; connected with the floor are chambers, which can be filled



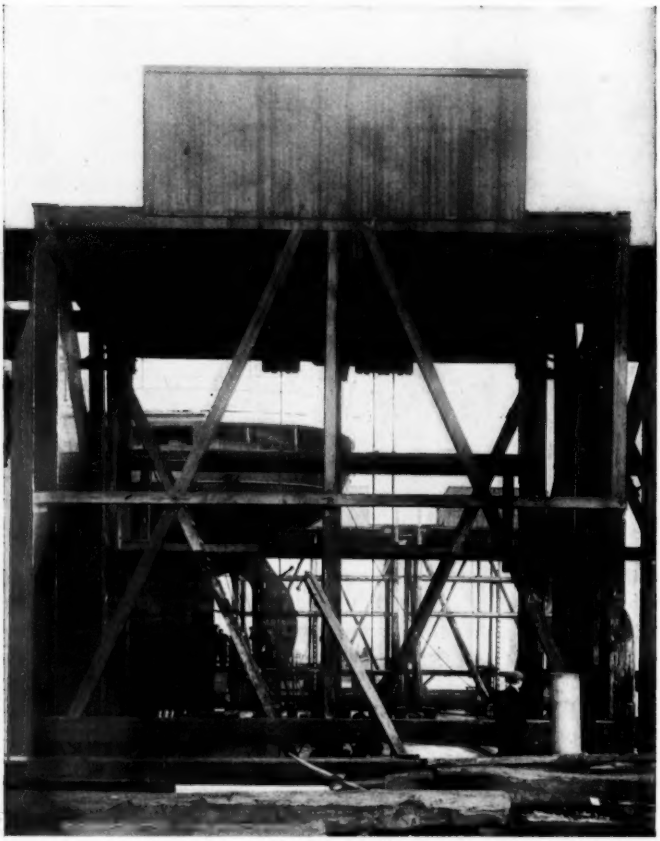
FLOATING DRY-DOCK ON EAST RIVER, NEW YORK.

with water, to sink it, or with air, to raise it. The ship is floated above the cradle; the water is pumped out of the chambers, causing the structure to rise to the ship and then lift the latter out of the water; for convenience and better adjustment to the ship's weight and structural differences, floating docks are often made in sections, and are then known as "sectional docks." Of the latter type are the floating docks in present use on the East river front of New York, used for graving coastwise vessels, chiefly.

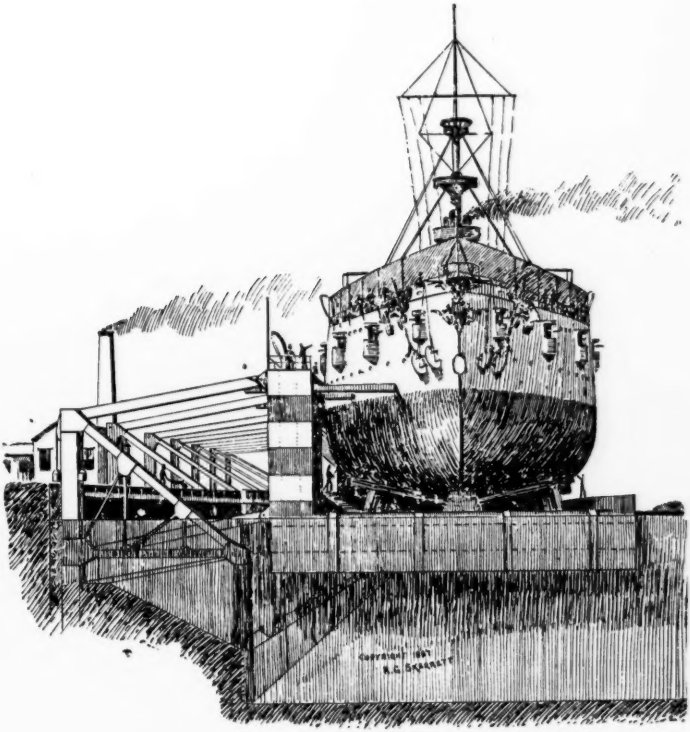
The illustration on this page shows one of these floating docks containing the steamer "Saratoga" of the Ward Line, running from New York to Havana. This dock is in ten sections; it is 380 feet long, 96 feet wide inside, 136 feet wide over all, and will float about

7,000 tons. A similar smaller structure, belonging to the same establishment, has nine sections; 280 feet long by 85 feet wide; capacity, about 3,000 tons; the view just below shows one of the sections.

The "off-shore" dock is a development of the sectional floating dock; in this type there is a submerged pontoon with a vertical extension above water on one side only, the purpose of the latter being to give stability to the structure and provide room for the pumps and other plant; the dock is placed parallel to the shore, with which it is



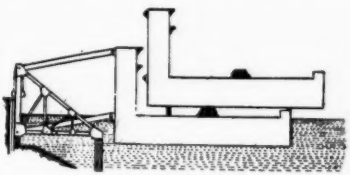
ONE SECTION OF FLOATING DRY-DOCK, SHOWING THE STERN OF THE "SARATOGA."



AN OFF-SHORE DOCK HANDLING AN ARMORED CRUISER.

connected by means of hinged booms moving in a vertical plane and permitting the dock to rise and fall.

An off-shore dock capable of docking a 17,000-ton ship, it is said, has recently been built for the port of Hamburg. There are manifest advantages in the off-shore dock as against the excavated or fixed form of dry-dock, and it will very



OFF-SHORE DOCK HANDLING ONE OF ITS OWN PONTOONS.

The cuts on this page are reproduced by courtesy of R. G. Skerrett and the New York *Times*.

probably be largely adopted in future; on the other hand, it requires a much greater depth of water. In the New York *Times* of October 31, 1897, appeared an interesting description, by Mr. R. G. Skerrett, of the off-shore dock and of several variations of the type. In one of these, called the depositing dock, the shore-work and booms are attached to a floating outrigger, and the whole dock can be towed from place to place; the pontoons are made in the shape of fingers, with water intervals between. A gird of heavy steel beams is fitted against the shore, the fingers of the dock slipping in between. A ship is taken upon the dock, towed to the gird, the fingers are run in, the dock lowered and removed, and the vessel is left deposited on the gird, convenient for repair, while the dock is free to go off to handle other craft. There is also a type, styled the "self-docking floating graving dock," which, apart from other differences, has movable end-caissons, by which it can be closed so as to become a floating graving dock, capable of navigation. The off-shore dock and its variations are essentially an English development, the credit of which is given to Messrs. Clark and Stanfield.

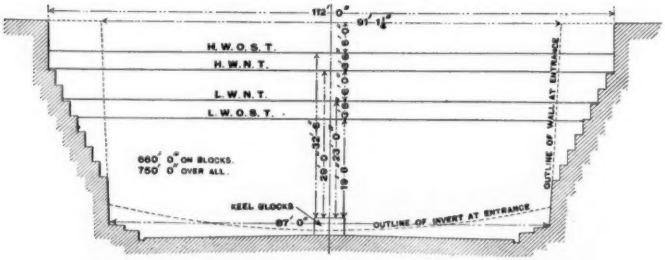
Another form of graving apparatus is the hydraulic lift, whose prototype is the celebrated structure at Bombay, the largest of the kind in the world, being capable of taking vessels weighing 5,000 tons, and having been tested to 12,000 tons. This is a very costly, but very perfect, machine; it consists of two parallel rows of eighteen iron columns secured to the rock bottom of the harbor, each column being 100 feet long and 7½ feet in diameter. Each column carries two presses with solid rams, 14 inches in diameter. The rams are secured to cross-heads, from which depend two rods supporting below water cross-girders upon which the 380-foot pontoon rests. The cross-girders are not connected longitudinally. The hydraulic presses are divided into three groups, controlled and operated by one man. The Bombay lift was designed for the P. & O. steamers before the opening of the Suez canal, since which event, however, those liners find it better to dock at Portsmouth.

Beside graving docks, there are what are known as ship-railways, by means of which vessels can be floated into a cradle that runs upon an inclined railroad resting at one end on the harbor bottom and at the other extending up to dry land; the cradle is drawn out by a steam capstan, usually, and ropes and chains. Ordinarily the use of a ship-railway is confined to small vessels, and usually they are pulled out lengthwise; but in various parts of the world broadwise docking has been very successfully practised. The most notable apparatus for the latter operation is at Bordeaux, where vessels up to 310 feet in length and weighing 1,800 tons can be hauled out laterally.

GENERAL VIEW OF THE PORT OF SOUTHAMPTON, SHOWING THE EXTENSIVE DOCKS.
By courtesy of the General Manager of the London & South Western Railway.

Where it is desirable—as it is in most cases—to combine graving and repairs to hulls or machinery in one docking operation, the dry-dock lends itself the most readily to the work, although for small vessels the ship railway is a very convenient machine, and, for graving only, the floating dock, if of sufficient size, answers admirably.

For large steamers the graving dock should be fully equipped with permanent derricks, sheer-legs, and shops, for taking out, repairing, and replacing boilers and parts of engines; in fact, it should be supplied for making all minor repairs without delay or loss of time. Such are the arrangements made in other ports than those of the United States, and in profusion. It is stated on intelligent authority that in Portsmouth, England, alone, there are now a greater number of dry-docks than exist in the United States. Liverpool's famous dock system, made indispensable by the great range of the tides in the Mersey, amounting to 30 feet or more, has about twenty



SECTION OF PRINCE OF WALES GRAVING DOCK, SOUTHAMPTON.

By courtesy of the General Manager, London & South Western Railway.

graving docks in connection with her forty or more magnificent basins, which stretch, half a mile wide, for six miles along her side of the river, not counting those upon the opposite bank at Birkenhead; generally the graving docks are conveniently placed in a corner of the basins, in close proximity to the repair-shops, and are marvels of enduring workmanship. The three graving docks in the Herculaneum docks are each 760 feet long by 60 feet wide, on the floor, excavated out of the solid sandstone rock and built of stone masonry.

To enumerate many such instances would be easy, but tedious and unnecessary; it suffices to say, in general, that outside of the United States the provision for public graving docks is universal, and it seems about as needless to describe them as to describe the physical characteristics of European streets known by all to exist. But there are suggestive lessons to be learned in several fields from some of the examples of graving docks on both sides of the Atlantic. We may

THE ABERDEEN DRY-DOCK.

take at random the case of the port of Hull, to begin with, where in 1880 the mercantile community awakened to the economical and commercial importance of increasing its dock facilities, although it was already fairly well supplied, the celebrated Albert Dock having been in service since 1869, besides a number of smaller ones. A site of 192 acres was secured, within which a basin covering 46½ acres was constructed, with two miles of dock walls from 52 to 62 feet in

BUILDING THE NEW DOCK GATES, ABERDEEN, 1884.

The illustrations on this page are published by permission of G. W. Wilson, Aberdeen.

height, the range of the tide being 22½ feet; as necessary concomitants there were a lock entrance, 550 feet by 85 feet, 12 miles of railroad extensions, an artificial entrance channel, quays, sheds, hydraulic cranes, etc., besides two large graving docks. These works cost £1,355,392 ($6,750,000), or £29,147 ($105,735) per acre, including the two graving docks and their equipment; not including equipment, the cost was about £21,450 ($107,250) per acre, which is equivalent to about 10s. ($2.50) per square foot. The cost of the graving docks alone was £130,800 ($654,000). This work consumed five years in building. A large part of the site had to be excavated. The foundations of special parts of the structure had to be upon piles; the rest upon stone rip-rap. It can be used by vessels of the largest class, drawing 26¾ feet. Previous to the opening of the new docks, the tonnage of the port was steadily decreasing, but, after the opening, it steadily increased, many new trades being established.

About the same date the port of Havre added to its already extensive system two large graving docks about the size of those just described; these were excavated in the solid ground, and are built of concrete. The two fine views of the Aberdeen Dry-Dock, showing it under construction, present very clearly the distinguishing features and magnificent workmanship of that famous structure, as well as a good deal of the detail. The Calliope Dock, at Auckland, New Zealand, 500 feet long and 40 feet wide on the floor, and giving 32 feet of water on the sills, is another notable graving dock; it was excava-

THE DRY-DOCK AT NEWPORT NEWS, VA., U. S. A., PARTLY EMPTIED.

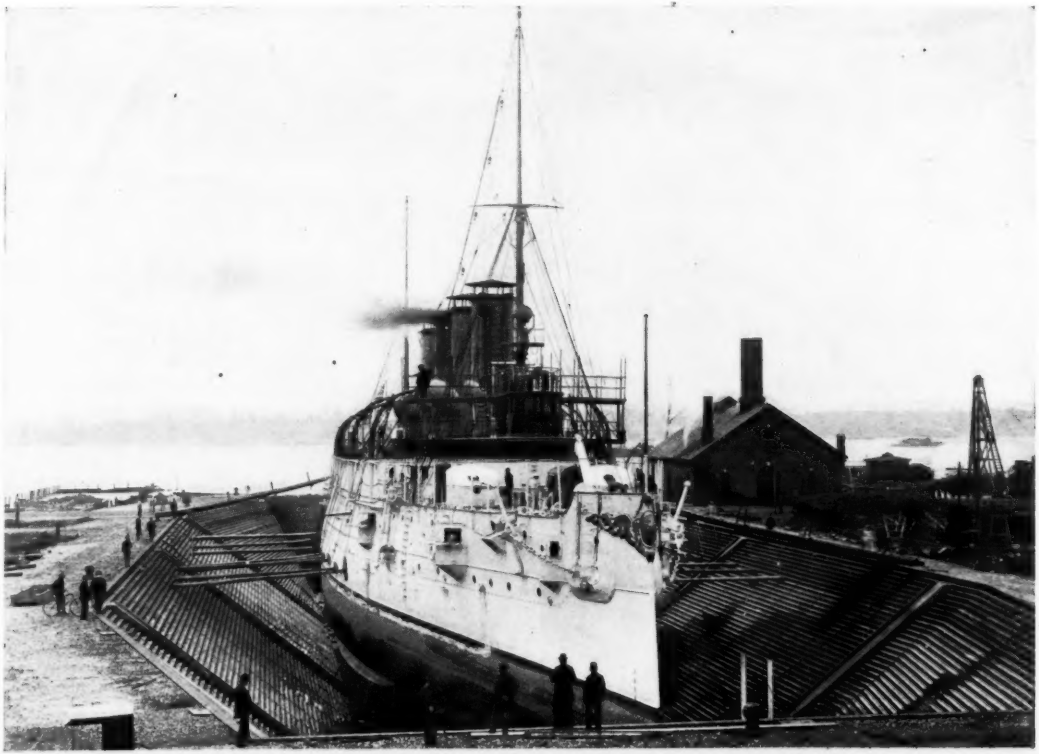
ESQUIMAULT DRY-DOCK, NEAR VICTORIA, B. C.

ted out of the solid rock, with altars and walls of rubble concrete. Its entrance is closed by a wrought-iron caisson, 83 feet by 15 feet by 41 feet. At Hull, gates are used.

Wherever the Union Jack floats, the British government, or a colonial government,—which, for the object in view, is practically the same thing,—has its splendid graving docks. The "morning drum-beat that goes round the world" has its counterpart in the cordon of docks provided for British commerce and British battle-ships. One

U. S. BATTLE SHIP IOWA IN THE LARGE DRY-DOCK AT THE U. S. NAVY YARD, BROOKLYN, N. Y.

of the finest modern examples is the Esquimault Dock, near Victoria, B. C., herein illustrated. This is a typical masonry graving dock. It was commenced by the government of British Columbia and completed by the Dominion of Canada, the imperial government contributing £50,000, in return for which Her Majesty's ships have priority of entrance and free dockage for fifteen years. At this point the range of tides is very variable and uncertain, being about ten feet normally, but remaining practically level for days together. The capacity of this dock is 450 feet by 65 feet with a depth of 26½ feet, sometimes increased by the tide to 30 feet. Its site was solid ground; the walls are of rubble concrete faced with sand-stone; the altars and timber-



DRY-DOCK AT THE UNITED STATES NAVY YARD, LEAGUE ISLAND, PENNSYLVANIA.

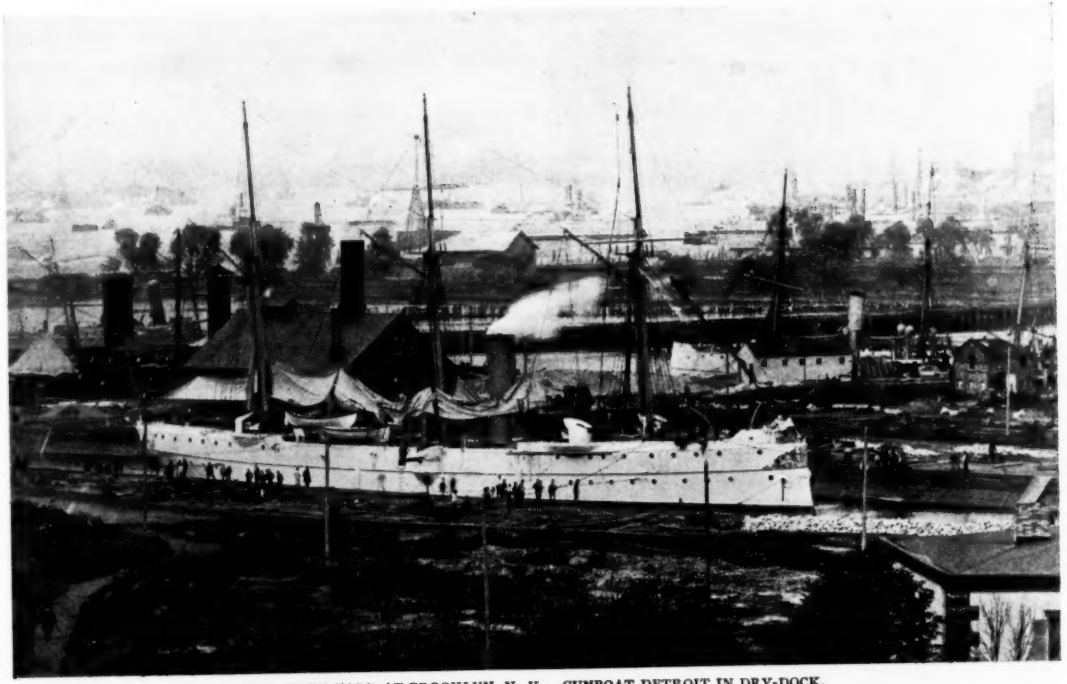
A "SIMPSON" DRY-DOCK IN COURSE OF CONSTRUCTION.

slides are of masonry. It is closed by means of an iron caisson having a displacement of 530 tons and weighing 294 tons, besides 180 tons of concrete ballast. The caisson is constructed with a lower chamber for water ballast, and an upper flotation chamber; it has two keels, which rest upon fixed rollers, over which it is drawn by steam-power chains. As there has long been a dispute between the advocates of stone and timber dry-docks as to their advantages, it may be of interest to note that the Esquimault Dock cost about $1,500 per lineal-foot, fully equipped; and it is stated that an extension in length would cost about $1,000 per foot for the dock-structure alone. Wooden docks of similar capacity have cost about $1,000 per foot, but two at the Brooklyn navy yard are said to have cost $640,000 each, which would be somewhat more than $1,000 per foot; this, however, does not include the very extensive repairs that subsequently were necessary. It should be borne in mind that there are other points of comparison besides cost. On the Atlantic coast nearly all the later graving docks are of wood, including the United States government docks at Port Royal, Norfolk, Brooklyn, and League Island; there is also an older dock, of masonry, at Norfolk. Of private graving docks there are the Newport News Ship-building Company's establishment, the Cramps' dock on the Delaware, and one at Baltimore,—all of wood.

All of these wooden docks are of the kind known as the Simpson dock, from its inventor; its typical construction, as first adopted, is shown in the illustration on the opposite page and comprised a wooden floor, as well as wooden walls and altars; but it was found that the wooden floor was often lifted by the upward water pressure from underneath, and one dock, at least,—that at Portland, Oregon,—it is said failed from this cause. The modern type has a concrete floor with wooden sides, and generally is closed with a floating iron caisson. The League Island dry-dock is 500 feet long, 130 feet wide at the top, and 32 feet deep; it cost $550,000. About 7,500 piles were required to support the bottom and sides; it will take a vessel 400 feet long by 70 feet beam on 25 feet draft. The caisson is 88 feet long at the top, 54 feet on the bottom, 20 feet wide, and 32½ feet deep; its keel presses against a heavy sill, on the face of which is a semi-cylindrical strip of rubber, serving as a gasket to make a water-tight joint under the water pressure. This device is the one commonly used for the joint. The caisson is emptied and filled by special pumps.

The colonial government's graving dock at St. Johns, Nova Scotia, is said to be one of the finest of its class on the Atlantic seaboard; this also is a "Simpson" dock. At the time of its completion it would take any merchant vessel afloat, except the Great Eastern. It

THE DRY-DOCK AT HALIFAX, NOVA SCOTIA.



U. S. NAVY YARD AT BROOKLYN, N. Y. GUNBOAT DETROIT IN DRY-DOCK.

is 610 feet and 10 inches long, from head to outer gate-sill, has 558 linear feet of keel-blocking, and is 25 feet deep. It is situated at River Head, the western end of the harbor of St. Johns, in an excavated site. It has a concrete bottom, and is closed by means of a gate moved by a steam capstan.

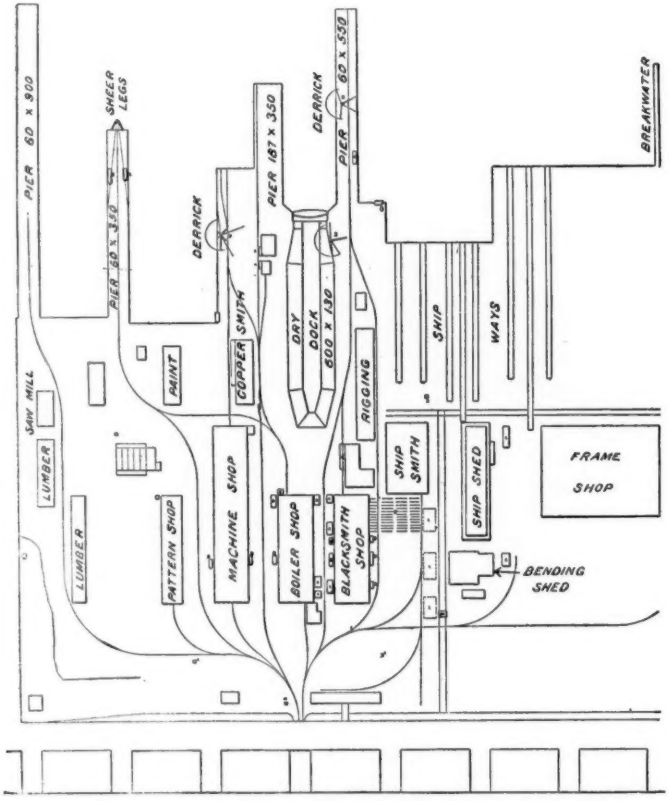
The dry-dock at Halifax, in which the Indiana was docked, is 620 feet long, 89 feet wide in the entrance, 102 feet across the top, and 28 feet deep at mean high water. It was excavated in solid rock. It is of brick and concrete, and belongs to the Halifax Graving Dock Company, Limited, a private corporation. The Indiana is 348 feet long over all, and 69 ft. 3 in. beam, drew 24 feet of water, and weighed nearly 10,000 tons when in the dock.

The Newport News dry-dock is 600 feet long, by 84 feet and 9 inches wide, by 25 feet deep. It stands on piles throughout; in most other respects it is similar to, and practically identical with, the St. John dock. The general plan, furnished through the courtesy of Mr. C. B. Orcutt, on page 462, shows the location of the dock at the entrance to the ship-building yards of the Newport News Ship-Building Company.

At present there are no graving docks on the Atlantic coast of the United States south of Port Royal; Naval Constructor Hichborn, in the report above mentioned, calls attention to the suitability of the harbor of Algiers, on the Gulf coast, for the establishment of a dry-dock; and very recently the directors of the Port Arthur Dock and Channel Company decided to build a dry-dock at Port Arthur, Texas, capable of taking a vessel 500 feet in length and of accommodating at one time any two United States cruisers now afloat. It is of interest to note in passing that the capital for this enterprise is to come from Holland.

On the Pacific coast of North America there are only a very few graving docks; besides the Esquimault Dock, a fine wooden dock in Puget Sound, and the one which failed at Portland, there is the very expensive Mare Island dock, built of granite and concrete, which was begun in 1878, and is said to have cost $2,500,000 (£500,000). At the Union Iron Works in San Francisco there is an hydraulic dry-dock somewhat similar in construction to the Bombay Lift, above described. It consists of a submerged platform built of cross and longitudinal girders of steel, with keel blocks and sliding bilge-blocks, which is raised by means of thirty-six hydraulic rams with a traverse of 16 feet multiplied so that the platform plays 32 feet vertically. The support consists of seventy-two iron cylinders driven full of piles. This plant lifts 6,000 tons, and handles, on an average, more than ten vessels per month.

Other facilities for encouraging and fostering commerce—not only that which exists, but that immensely greater commerce yet to be created for the United States—in the shape of more complete systems of lighting and marking channels, better harbor entrances, more convenient arrangements for examination by revenue and health officers, etc., are doubtless needed in some, if not in all, United States ports. But in these respects the country has not been greatly neglected in the past, and, with the added impetus that would come from improvements along the lines marked out in this series of articles, it may fairly be said that the harbor conditions on the Atlantic coast of the



GENERAL PLAN OF WORKS, NEWPORT NEWS SHIP-BUILDING AND DRY-DOCK CO., NEWPORT NEWS, VIRGINIA, U.S.A.

United States would need little improvement not already accomplished or in contemplation. Development in these respects would naturally go hand in hand with new necessities.

On the Pacific coast of the United States, however, very much remains to be done in providing the harbors themselves. Only a few months ago the board appointed by the United States congress to locate a deep-water harbor for commerce and of refuge on the Pacific coast completed its investigations, and selected San Pedro, California. In the admirable report presented by that board occurs the following suggestive sentence, of much interest in connection with our present subject: "The recent changes in the requirements of deep harbors, and the methods used in their construction and maintenance, are in favor of a harbor where commercial facilities are afforded by interior basins rather than by exterior wharves, in which basins perishable types of bulkheads or piers may be displaced by permanent structures of such reasonable cost as the growth of commerce may justify."

But, whatever the local conditions may be in United States ports, their modern commerce is in its beginning, and there is a common interest, not only on the seaboard but especially in the interior, in stimulating it, in building it up, in creating it, to be a stay and support for generations yet to come. The country has seen and been blinded by its wonderful material progress in the last thirty years, accomplished without needing, for the time being at least, commerce with other nations under home control. But the times have changed; the home field is in many respects nearly occupied; the commercial era is at hand for the United States, just as twenty years ago the industrial era presented itself.

The late ex-Commander Gorringe, U. S. N., himself a shipbuilder, once said to the writer that for every man engaged in the production of a ship there were fourteen employed in the commerce which that ship served; from this he argued that it was much more important for the United States to own and operate many ships than for few people to make an excessive profit in building the small number made possible under the American protective policy and the outgrowing navigation laws. However men may disagree as to the prime cause of the disappearance of American shipping, there can be no question at this time of the desirability to the United States of taking every reasonable means of fostering and encouraging it.

COST-KEEPING METHODS IN MACHINE SHOP AND FOUNDRY.

By Henry Roland.

III.—CONTROL OF THE STORE-ROOM AND CHECKING OF PIECE-PRODUCTION.

USING general terms, there are in the foundry and machine-shop or factory rough stores, work in progress, work delayed, finished stores, and assembled or completed work.

Rough stores include everything bought from the outside, and may include finished articles, as screws and bolts, bright shafting, finished pulleys, finished special parts, and so on. Except pig iron, coal and molding sand, and tool-room supplies, rough stores are, or invariably should be, checked into the rough-stores room, and thus placed in care of the rough-stores keeper as soon as received at the works. The foundry stores, flour, nails, facing, and so on, might well go to a store-keeper in large establishments, but commonly do not, being accessible at will to those who have occasion to use them, with the result of much waste which might be avoided if these miscellaneous supplies were in charge of some responsible person and served out in known quantities only to those who should receive them. Rough stores for the brass foundry—copper, tin, spelter, and so on—are usually in charge of the foreman in small shops, or of a stores keeper in large shops, because they are costly and in portable form, and thus offer temptations to petty thieving, or constant thefts not at all petty in totals. Rough machine stores are almost invariably placed in charge of responsible keepers, as they include a vast variety of articles which may be wasted or stolen, if open to all hands; these stores should be checked into the stores-room, thereby making the store-keeper their responsible custodian, and checked out of the stores-room only on authenticated orders, such stores-room books being kept as to always show what has been received, what has been given out, and to whom and on what account stores have been delivered.

Space does not permit the giving of approved details of rough-stores arrangement and book-keeping, which are of necessity greatly varied by the nature of the manufactures to which they pertain. The rough stores of a screw-making establishment may consist wholly of metal bars and rods, or, in case of a general machine-shop, rough stores may include a very great variety of materials in greatly-differing forms. Stores-room book-keeping may be nothing, the stores-room

keeper merely filing the orders on which he delivers material, or it may be a complete system, including journal and ledger, the journal only being kept in the stores-room. Two journals are often used, one for each alternate day, so that the one in use on the previous day can always be in the book-keeper's office. Such stores-room book-keeping should be done as will give accurate knowledge of all transactions, and the rough-stores room should have internal conveniences that will permit all its multifarious contents to be readily reached, handled, weighed, or enumerated.

Shop jobs are supplied with material from the stores-room on job orders, as already exhibited. When a job is completed, it goes, in heavy work, commonly to the erecting department, but, in light work, it goes to the finished stores-room to await the demand of the various assembling departments. If, through some emergency or a change of plan, a job is delayed in its finishing, it then becomes a thing without a place, belonging in neither the rough stores, the finishing department, or the finished stores. A delayed job is always expensive, and should be sedulously avoided. Perhaps the best disposition of the delayed jobs of small work is to box and tag it, and place it in the rough-stores room. If left in the finishing shop, shoved out of the way and often out of sight, it may be forgotten altogether, and is at least liable to be short when work is resumed upon it.

Finished stores demand suitable internal facilities, and careful book-keeping, showing totals of finished stores on hand at the shortest possible notice.

Where, as in the case of the Yale & Towne establishment, the finished stores include many hundreds of different pieces of small size, racks of boxes of uniform dimensions may be used, two boxes deep, with alleys between the racks, each box bearing the name and number of the piece and having a flush card-slide on its front side, the card recording the original number of pieces contained and each withdrawal, each box having also three target pins, and three targets, white, red, and blue. With all three targets on the upper pin, white exposed, the box contains an ample supply of parts; white on the first and red on the second target pin show that the supply is running low; while the blue target exposed on the lower pin shows that the stock must be replenished immediately. Thus, by merely observing the targets, the finished-stores keeper can tell what parts are full, what ones are short, and what ones must be ordered into manufacture as soon as possible, without moving a box or examining a card or book. These targets give constant visual warning of low supply, and the Yale & Towne finished-stores box, as shown in the engraving

below with all the targets displayed, gives a valuable item of established finished-stores room practice.

Assembled small wares or machines go to the shipping department, where again everything should be checked in and checked out, and such a set of books kept as will give full information.

The De La Val shops are arranged with the rough stores at the extreme south end, under the offices; next north comes the finishing-shop, with tools arranged so that, as far as possible, those nearest the rough stores are first used. The assembling floor, testing floor, and painting, Japaning, re-assembling, and boxing and shipping rooms, are in sequence north of the finished stores, thus giving the least possible transportation inside the shop, which is a matter of great importance. Many shops unconsciously add a considerable percentage to prime cost by handling of jobs in process of finishing and finished. Every handling costs money, and in more ways than one.

YALE & TOWNE FINISHED-STORES BOX.

In the matter of thefts, losses, spoiled work, shortages, and disappearances, the most surprising and incredible happenings are of daily occurrence in the machine-shop as well as in the world at large, and, just as we occasionally read of the wholly unaccountable disappearance of some individual respected and well known in his circle, so work of all kinds, jobs large and small, disappear from the machine-shop or factory as if swallowed up by the earth, and in many cases leave no trace behind which ever leads to recovery.

A large, finished, double-cranked refrigerator engine-shaft, 11 or 12 inches in diameter, perhaps 20 feet long, and weighing several tons, disappeared from the De La Vergne shops, Port Morris, New York, and left no trace whatever behind. Long afterward this shaft

was found, quite accidentally, by one of the De La Vergne officials, who saw it lying unclaimed on the ground in Cincinnati, thought it looked like a De La Vergne shaft, found the marks on it, and recognized it as the lost piece. No trace was ever obtained to tell certainly how it came there. It was probably a case of unauthorized shipment, ambiguous billing, and so on, which permitted the separate flat-car load formed by this lost crank shaft to accompany an authorized shipment of machinery to the west as far as Cincinnati, where it became a stray, was side-tracked, and, having no distinguishing marks, was finally laid on the ground for developments.

This was out of the common, but losses of great value are not exceptional in the machine-shop and foundry.

In a Chicago foundry the iron for the day's heat was broken, weighed, and piled in the yard before noon, and the weights came short in the total of finished castings, wasters, and sprues with unvarying regularity,—about 100 pounds on every day's work. The foundry adjoined a machine-shop, and the broken pig was piled where a strapping Hibernian smith's helper could easily secrete pieces, and he carried out about 50 pounds morning and night, and disposed of it at a convenient junk-shop. The smith's helper was detected going out of the gate with half a hundred weight of pig iron slung over his shoulders and concealed by the very loose rough jacket he wore. He went to jail, and the foundry weights came right. Here the careful Germans who ran the foundry kept their weights closely enough to detect small losses.

In the large Sag Harbor silver watch-case factory all the silver in the establishment was checked into the silver-keeper's strong-room, both as rough stores and work in progress and finished stores; everything was weighed out in the morning to the melters and to the finishers, and weighed in at night, and the silver-weights book was balanced before the gates were opened to let the hands out. The proprietor walked through the shop two or three times one day, and, being above suspicion, he easily stole 120 ounces of his own silver, and then waited for the disturbance which he expected to follow a 120-ounce shortage in the silver balance at night. Nothing came. As the silver-keeper was leaving the place, the proprietor gave him a smile and a nod: "Balance all right, eh?" "To a quarter of an ounce," replied the silver-keeper. Nothing more was said that night, but the next morning trouble began in earnest. The book-keeping system was all right; the silver-keeper and his weighing and checking clerks were lazy and careless, and the balancing of weights was habitually forced. No one was discharged, but the weight balance was a matter of anxiety from that time on.

In a book-bindery a million copies of a medical almanac were in progress. A girl folder who had folded twelve thousand sheets erroneously took the stitcher and coverer into her confidence, and the three girls, all on piece-work, passed the books through to completion, had their piece-work books checked up with credits for the work, passed the greater part of the spoiled twelve thousand copies down the soil pipe, and took the remainder out of the bindery at night in their clothes and lunch-baskets. The shortage was never explained, the writer learning of the incident from one of the culprits, who told it as a good joke on the bindery.

In a sewing-machine shop one hand never spoiled work. A deep mill race ran under his window. When the dam went out in a freshet and the race went dry, it exposed many thousands of pieces of that man's spoiled work, which he had thrown into the water, making good his shortage in job-ticket numbers by eating noon lunch with the finished-stores keeper in the finished-stores room, and filling his lunch-basket with finished parts from the finished-stores. The finished-stores accounts were not subject to trial balance before the dam went out. Afterward the finished-stores books were balanced often, and the stores-keeper lunched alone.

The Rock Island Railroad shops in Chicago had about seven or eight hundred hands in the early sixties. Two new helpers sent down from the office were put at work; they looked smart enough, but were of absolutely no use anywhere, and were passed from one department to another, being everywhere made the butts of the workmen, who were accustomed to "main office" hands—as men sent down from headquarters simply to draw pay were called. The whole place, from the paint-shop to the boiler-shop, had fun with those two helpers for a couple of weeks, and then came a Saturday afternoon when all the workmen were asked by their foreman to give up their tool-box keys as they left the departments for the day. Some of the men did not wish to let their keys go out of their hands, but all were taken up. At the exit-gates stood the two "main office" hands and two policemen, and it was very slow work passing out of the gate because, at a nod from the "helpers," a man was taken into the oil-room, where there was vacant floor-space, and searched before he was allowed to go out. No one was held, and only about half were searched. More than eight hundred dollars' worth of "company" material was taken from the workmen at that single search, including samples of nearly everything used in making freight and passenger cars and locomotives. Two of the blacksmiths, father and son, Englishmen, two of the best men in the forge-shops, were found to have carried out, by some undiscovered method, an anvil, a large old-fashioned smith's

forge bellows, two vises, a large lot of tongs, files, axes, fullers, formers, sets, hammers, and sledges, and, in addition, more than ten tons of bar iron and steel. They intended soon to start a shop on their own account. The two smiths were sent to prison, and a few of the thievish workmen were discharged, but, taking it all together, there was very little said. The tool-box keys were returned Monday morning without a word; some of the hands' tool-boxes had been relieved of company property, but nothing was said to most of the men, the company, probably, justly blaming their own lax methods—which gave the opportunity for wholesale plunder—more than the men who "took" what was not properly guarded.

Every man familiar with American shops can recall numbers of similar tales, all made possible by lax shop-methods. Most mechanics are honest, perfectly honest. Many workmen will cover up a bad job, and many others will take a file or two, or a little material they want to use, carrying it out of the shop without saying anything to anybody.

A small class of mechanics, often very bright and capable workmen, are simply vicious thieves, and display incredible skill and ingenuity in devising methods by which a slight gain to themselves may be secured at no matter what expense to their employers.

Many swords and bayonets were lost in tempering in a Massachusetts armory many years ago. Finally the boss forger tried his hand at tempering with a secret heating compound and bath of his own, and all losses ceased immediately; the secret of the tempering bath was sold to the firm for a large sum, and the successful temperer left for parts unknown. After his departure a large unused tempering-vat was found to be filled almost full of temper-cracked sabres and bayonets. Slack rough-stores accounts and collusion with the sword and bayonet forgers and grinders had enabled the dishonest temperer to obtain untempered pieces to make good his work spoiled in perfecting the non-cracking tempering bath, the secret of which he sold to the firm.

In another case, reported by a correspondent, an establishment using what was supposed to be a reliable system of shop accounts found at the end of the year six thousand of a certain piece recorded as paid for at piece-rates, which could not be found or accounted for in assembled work.

These numerous anecdotes are given as showing more plainly and conclusively than any argument could do the absolute necessity of a complete bookkeeping and checking system in the shop and factory, with a sufficient clerical force to carry out all details with promptness. Short accounts make long friends. It is not enough to have a

reliable method of handling work and keeping track of it in the shop. There must be frequent balances and actual counts. The counts can generally be made very quickly by weighing, to show that the actual condition of work corresponds with the footings of the accounts.

Piece-work and job tickets make prime-cost keeping easy; day-work tickets, carefully kept, serve the same purpose with a little more labor. Day-work tickets are very often incorrectly filled by workmen and foremen, who are inclined to turn in short time on bad-luck jobs, charging the difference to the work which went through in quick time. But original records cannot well go back of the workman and his immediate superior; so this uncertainty of time division must be regarded as an ever-present possibility where a day workman is employed on more than one job in the same day. Many different systems of shop-accounts can be used in dealing with shop-operations. The simplest is best, but simplicity must not be gained at the expense of the possibility of accuracy. In general terms, the tendency of present practice is towards a multitude of accounts, and elaborate sets of books, the same as the tendency in the shop is towards special lines of work and special tools and appliances, whereby processes are subdivided and steps are simplified, so that both shop-processes and shop-bookkeeping progress toward that mere mechanical routine which demands only small ability and no exercise of ingenuity or skill, and thus ensures accuracy from mediocre agents.

Constant vigilance must be exercised in the shop, not only to secure good work, but to avoid dishonesty on the part of the workmen. It has been said that most workmen are honest. It cannot be said that all are honest, nor can it be said that all honest workmen can always do honest work. The superintendent must avoid placing tempting opportunities for petty frauds before his men. Workmen must not be left to their own devices.

Tool-room supplies include a great number of costly articles which should never be allowed to go out without a record of the taker. The check system is very commonly employed, each workman being supplied with from five to ten small brass checks stamped with his individual number. The workman gives one of these checks to the tool-room keeper with the request for a desired tool, and the tool-room keeper places the check in the vacancy left by the delivered tool in its rack. The check makes the workman stand charged with the missing tool until it is returned to the tool-room, and the workman has his check returned to him in exchange therefor. Oil is often kept in the tool-room, and is also often exposed in the shop in an "oil cabinet," to be taken by the men as they see fit. Cotton

waste is often kept in a bin or barrel, accessible to the men, and in this form is a fire danger, besides leading to wasteful usage. Files should always be kept in the tool-room, and delivered only on a foreman's order. Many shops make it a rule to deliver a file only in exchange for a worn similar file ; but this is not a good rule, except in cases where the workman is employed continually on the same class of work. Stubb's wire and gun rods are often kept in the tool-room rather than in the rough-stores room, and should always be delivered on job order only. Spring wire and brass and German silver-wire, and sheet brass and sheet steel and tool steel, are also, in some shops, stored in the tool-room, and should be delivered only on job orders, though many tool-room keepers are permitted to deliver wire and sheet metal stock without orders. Where this is done, all such material should be charged to expense when it enters the tool-room. For accurate cost-keeping no stock can be delivered to a workman except upon job ticket or job order. Still, it is perfectly true that where a workman wants, say, one-eighth or one-sixteenth of an ounce of small spring wire, the time expenditure in keeping the record may be many times more than the value of the material delivered. The workman may spend some minutes in finding his foreman and obtaining a tool-room order on the job ticket for the wire he wants, and, if the tool-room keeper's accounts must balance, he must make a record ; so that, in case of extremely small deliveries of stock to workmen, the shop is loser by keeping the record. This makes an excuse for not keeping the tool-room stores account with accuracy, and leads some shops to charge all such stores in a lump to the expense account. The same general objection can, however, be urged against all attempts at accurate cost-keeping, and, since accurate cost-keeping is now held to be an essential part of good shop-management, the formalities needful to securing prime-cost records must not be ignored. In this connection it is proper to note the fact that wire and sheet-metal supplies should have a large percentage added to the original cost on the job tickets, say, from 50 to 100 per cent., as the larger figure does not in many instances represent the actual cost of time in placing the small amount of material needed in the workman's hands at the shop location where it is to be used. The fact that all stores incur shop charges and should bear a proportion of the expense account or "establishment charges" is elsewhere noted. Expense is created by everything brought into the shop, or produced by the shop, and must be recognized in every instance, if accurate cost-keeping is sought.

Many shops fail to understand this feature of total cost, but a charge of from five to fifteen per cent. on first cost of materials is

always justifiable as expense on materials not to be machined, or before machining or working in the shop.

Before leaving the finished-stores room subject, it is well to note that it forms a central element in the shop economy, and some shop accountants have therefore made the finished-stores room the central figure of a system of book-keeping, charging all work to the finished-stores account, and crediting everything given out by the finished-stores keeper. Such a system had an extended trial at the Yale & Towne factory, but was abandoned as involving too much book-keeping for the benefits gained. By this method the whole shop accounts center in the finished stores. The scheme has its strong advocates, despite the clerical work involved.

It is not enough that the keepers of the rough-stores, finished-stores, and tool-room should be simply not thieves; these officials must be of conscientious and untiring integrity, omitting nothing, however small and inconsiderable, that pertain to their duties. Nothing short of this will produce accurate records, and inaccurate records are liars of the most damaging description in machine-construction.

Estimating is based on prime cost and expense, or "establishment charges," as British shop accountants term them. It is therefore an absolute necessity that prime cost should be accurately known, since the expense account is divided into percentages on prime costs, or percentages on values of materials and other percentages on the total cost of labor used in the construction of work delivered. Consequently accuracy in all the details of account-keeping which have been mentioned is necessary, not only to prevent pilfering and the obtaining of pay for work not performed and the loss of material and finished work, but to enable the management to furnish estimates to inquirers at prices which include a living profit.

Although the vast labor of thus supervising and recording an infinity of small details, unimportant when singly considered, might lead the old school of founders and machinists to assert that the best way to manage a metal-working establishment at the present day is to let some one else carry on the business, it must be borne in mind that the demand for machinery is daily becoming both greater and more varied, and will continue to employ constantly-increasing amounts of labor and capital for many years to come, and that foundry and machine-shop management is one of the most important branches of commercial science.

THE FAILURE OF LEGISLATION TO ENFORCE RAILWAY COMPETITION.

By H. T. Newcomb.

THE purely American belief that there can be general, permanent, and effective competition among various corporate units collectively composing the railway system of a nation, and that such competition itself constitutes a substantial regulative force, has had abundant legislative expression. In the attempt to secure and perpetuate railway competition, provisions forbidding the consolidation of parallel or connecting lines have been inserted in American State constitutions, in acts of American State legislatures, and in the charters of carrying corporations. In pursuance of the same policy various States have, to the extent of their authority, prohibited arrangements, popularly called "pools," for the equitable division of competitive traffic or the earnings therefrom, and, through the persistence of a few doctrinaires, the United States congress, in 1886, inserted the fifth section, or anti-pooling clause, in the interstate commerce law, with every other provision of which it is in irreconcilable conflict. Finally the anti-trust law, by what many eminent jurists believe to be an unwarranted application of its terms, has been so construed as to prevent all agreements among railways in regard to the charges to be collected for services performed.

It is interesting to note that this apparent confidence in the saving efficacy of competition in transportation is practically confined to the United States. In England, where "joint purse" arrangements for the apportionment of earnings from competitive traffic are almost as old as the railway system, it is notable that an award made by Mr. Gladstone, acting as arbitrator in a controversy over the division of business among the four companies operating northward from London, was in force continuously from 1857 to 1871. France has been divided territorially among several great companies, each of which is practically free from competition in the field reserved to it; while in Germany and most other continental countries, as well as in Australasia, the business of railway transportation is a State monopoly.

The end of a decade during which legislative attempts to foster railway competition have been a principal element in the situation in the United States affords a fitting opportunity for inquiry concerning the success or failure of this peculiarly American policy. Though judicial interpretation has considerably modified what was at least

popularly supposed to be the legal effect and purpose of the interstate commerce law, the application of the anti-pooling section has been in no way restricted, and its enforcement has been practically continuous. It is not too much to assume, therefore, that the United States have now received whatever benefits can be derived from unrestricted competition; yet railway rates remain demoralized, and complaints of unjust discriminations in favor of particular persons, communities, and classes of property are loud and frequent. It is true that the penalties attached to rate-cutting, the payment of rebates, underbilling, and other fraudulent devices through which charges lower than those accorded to the general public are collected from favored shippers, have so far restricted those practices that those who ship in small quantities are no longer able to "shop" among the various roads over which their traffic can be forwarded, finally patronizing that which agrees to accept the lowest compensation. The statement made in an official report by Mr. C. C. McCain, the highest American authority on the history of railway charges in the United States, that "in former years the methods of the carriers were such that the instances where the published tariff was charged were rather the exception than the rule" is not applicable to the period subsequent to 1887; yet there is abundant evidence that concessions are regularly made to those shippers, or combinations of shippers, whose enormous wealth, or the extent of whose business operations, enables them to dictate terms to carriers, wherever alternate routes exist. It is impossible to doubt that the social consequences of unjust discriminations are vastly more disastrous when granted sparingly and reluctantly to a few, and that the unfair advantage accorded the individuals thus selected is much more valuable than when variations from the established rates are made at the behest of every sufficiently sophisticated shipper. Indeed, it is manifestly greatly to the advantage of the fortunate individual who is able to command a concession from the published rates amounting to all or nearly all the difference between a profit and a loss in the business transaction of which the shipment is a by no means unimportant part, that every other individual making similar and contemporaneous shipments shall be obliged to pay the regular charge. The interstate commerce law, which could by no means secure competition and at the same time abolish the ordinary means by which it is made effective, has secured for the larger shipper the inestimable privilege of reasonable confidence that the illegal favor which he enjoys can be secured by no small competitor.

There are other effects of so-called railway competition which are equally disastrous to public interests though not necessarily involving violations of the interstate commerce law. Unjust discriminations

may result from the establishment of different and inharmonious schedules of rates by independent railways, as well as from the action of a single road in performing similar and contemporaneous services upon variant terms for different individuals. For example, if A and B simultaneously ship equal quantities of the same commodity between the same points and in the same direction, and A is charged less than B, the commercial disadvantage resulting to the latter is neither more or less on account of the route traversed by either shipment. Similarly, it cannot be of the slightest importance to the residents of a district competing with those of some other district for the privilege of supplying a particular community with some necessary product whether the relatively unjust rate that deprives it of equality of opportunity in the market common to both is over a line owned by the corporation over whose road the traffic from the unfairly-favored locality must pass. Evidently, therefore, it is essential to an equitable distribution of the burdens of transportation not only that single railways shall charge similar rates for similar services, but that all railways capable of performing similar services shall establish and maintain identical charges therefor. Anything less than this involves unjust discriminations and demoralization. Uniformity in charges made by separate corporations involves agreement among them upon mutually-satisfactory schedules, and effective agreements upon the complex subject of railway charges require continuous machinery for joint and harmonious action. Beyond this, it has become plainly evident, within the last decade, that satisfactorily-permanent uniformity cannot be maintained unless there be established some system comprehending a substantial incentive for adherence to agreements after they have been formulated, and successfully substituting for the superficial spirit of rivalry and conflict now too frequently prevalent among railway managers thorough appreciation of the absolute identity of the corporate interests which they serve. As long as the ownership of the railway system continues to be distributed among a large number of legally-separate corporations with different security-holders, and their surplus revenues to be divided, in consequence, among distinct bodies of investors, the requisite harmonization of interests can be achieved, if at all, only by the division of all traffic for which two or more routes are, from a commercial standpoint, practically available among the carriers operating such routes, in proportions stipulated in contracts the observance of which may be enforced by judicial process.

Though railway competition enforced by statute has failed to secure the public against unjust discriminations, it might still receive some popular support, if it were possible to show that it has resulted in cheapening transportation. Here a somewhat plausible affirmative

argument can be made by the mere assumption, which will frequently pass unnoticed, that coincidence of time and place establish the relation of cause and effect. Average charges for railway transportation are, per unit of distance, lower in the United States, especially for freight, than elsewhere in the world. The whole period of the development of railway facilities has been characterized by a downward movement in rates of fare and freight which is one of its most salient features. Careful investigation of the incidents of this decline show clearly, however, that it is due to causes wholly extraneous to the railway system, except in so far as the enlightened perception, on the part of the officials having charge of railways, that the future of those properties is based upon the development of the territory contiguous and tributary to their lines, and that such development is largely dependent upon cheap transportation, can be considered an intrinsic cause. The genuine competition of trade, and not the pseudo-competition of transportation, is the cause with which the decline in railway charges can be logically connected. Persistent and powerful pressure is constantly exerted to secure concessions in rates, in order to place particular producing regions upon a better footing in markets already reached, or to extend the areas which they can supply. Such concessions, however slight, may be sufficient to enable one region to monopolize a market formerly common to several, and thus lead to demands upon other carriers reaching the common market from different directions. The sugar of Hawaii and that of Cuba and Germany thus find common markets in the United States, and whether the sale of one or both in large districts shall be profitable or the reverse is wholly a question of transportation rates. Salt from Michigan and Kansas meet in Iowa and other States on similar conditions, as do many other commodities in various portions of the country. Competing shippers in the same locality are always endeavoring to obtain more favorable rates than those accorded to their rivals; and, though these may be, under present conditions, temporarily secret, they not infrequently lead to open reductions. The use of particular commodities is often limited territorially by the freight charges from the points of production to those of consumption, and, when charges are too high on certain articles, substitutes produced nearer the points of consumption, or carried at lower freight rates, are frequently used. The charges for passenger transportation also, by limiting the distance to which agents can be profitably sent and otherwise hindering personal communication, effectively prescribe the limits of profitable interchange of commodities, and interfere with the territorial division of labor. In consequence of these facts, the whole force of commercial competition, the most amazing and tremendous

product of modern industrial and economic organization, is arrayed in continuous effort to secure ever-cheapening transportation. As a result, railway charges tend unceasingly toward the lowest rates that will produce a revenue sufficient in the aggregate to meet operating expenses, including necessary repairs and renewals, and, in addition, return to capital the lowest recompense for which it can be procured. As the latter is at any particular time a definite and ascertainable sum, it is evident that expenses of operation constitute the only controlable element. Here is found a barrier which legislative attempts to secure railway competition have erected against further reductions in charges made possible by economies in operation. There is thus imposed upon the public the burden of supporting, by rates otherwise unnecessarily high, this peculiar form of competition that is profitable to no one, and is the prolific parent of unjust discriminations.

Some of the wasteful expenses incident to competition may be enumerated here. Authentic statistics of the amounts paid by rival lines as commissions for securing business are very difficult to obtain, as the success of such practices depends very largely upon the degree of secrecy that it is possible to attain. The interstate commerce commission was able to ascertain, however, that nine roads paid out an aggregate sum of more than one million dollars in a single year in commissions on passenger business alone. It is stated on reliable authority that as much as $20.70 has been paid to secure a single second-class passenger from Chicago to San Francisco. The multitude of outside agencies and travelling agents maintained solely for the purpose of securing the business for their respective lines that might otherwise go by those of their competitors involves an expenditure so great, even during periods of comparative harmony, that it has been necessary to restrict their number by contract. The contract now in force limits to eight the number of these agencies that may be maintained in the city of New York by each of the nine roads competing for through west-bound traffic. As it is a fact of ordinary observation that such agencies invariably cluster in particular portions of the city and around particular corners, it is obvious that, under a system of joint agencies, the public could be accorded superior service at lower cost. During the too-frequent periods of unbridled competition, popularly denominated "rate wars," each participating road has its freight and passenger agents in every important city in the country, at a total expense for rents, clerk-hire, advertising, etc., that must be enormous. Four roads operating westward from Chicago are known to have expended $1,283,585 for outside agencies and advertising in a single year, during which rates were fairly maintained, while during an equal period one road out of New York expended $871,291 for similar pur-

poses. The competition of long, circuitous, and otherwise costly routes for traffic that would naturally traverse cheaper and more direct lines is another gross extravagance too frequently observed. Between Omaha and St. Paul, with a short-line distance of 373 miles, traffic is carried by a line 734 miles in length. From Chicago to New York twenty-one routes ranging from 912 to 1,376 miles compete for traffic, while between Omaha and San Francisco there are five, of which the shortest is 1,865 miles long and the longest 2,724. Besides the numerous regular and "tramp" steamships available for shipments from New York to New Orleans, more than ninety all-rail lines are each actively seeking a share in the business. The most direct of these is 1,340 miles in length, or 711 miles shorter than the longest. As an example of the waste of competitive train service, it is not necessary to add anything to the bare statement that forty-four trains leave Chicago for New York every day, and that similar duplication of service exists all over the country. No intelligent student of transportation doubts that, whenever it becomes possible, by means of the adoption of wiser principles as the basis of regulative legislation, to eliminate from the cost of railway operation these economically useless and wasteful expenditures, the saving thus effected will accrue to the benefit of the general public through the reductions in rates which will be thus permitted to result from the action and interaction of the commercial forces heretofore described.

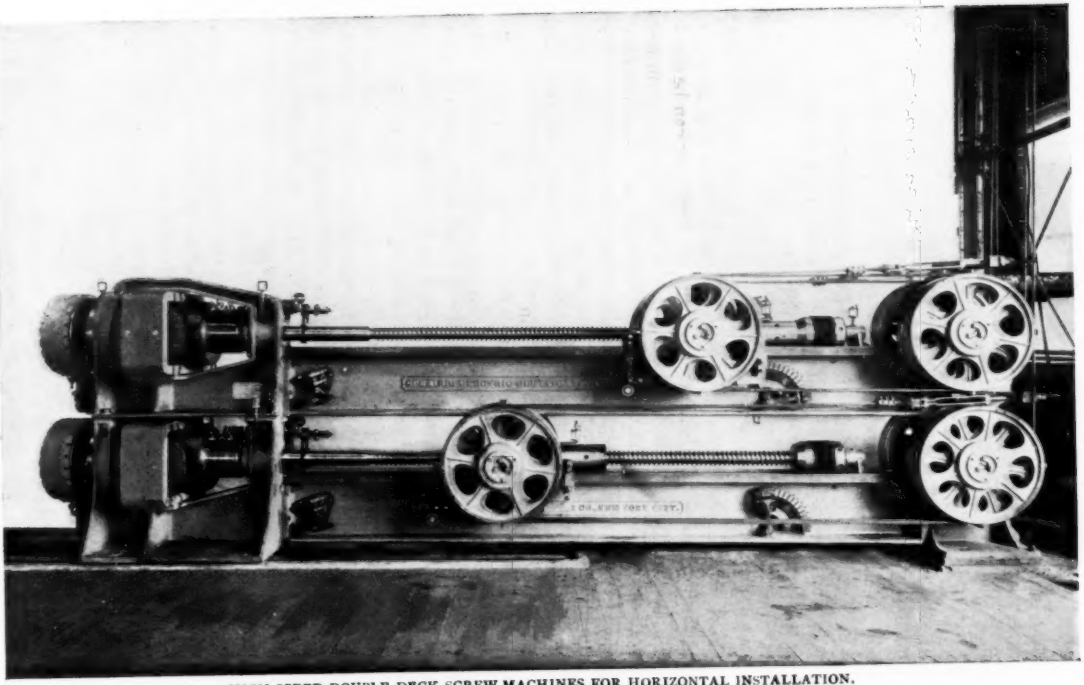
Though this rapid summary of the failure of so-called competition among American railways would be complete without it, it may be useful to indicate that it is not due to any cause invalidating the competitive principle as applied to general business and within its proper sphere, but rather to the fact that the modern conditions of land transportation are such that genuine competition among the agencies employed is impracticable. Far the greater number of railway stations are dependent upon single railway lines, and the vastly larger portion of railway traffic has no alternative routes available. To these stations and this traffic the relation of the railway corporation is that of a monopoly, and from them the latter can and will, within certain limits and with certain qualifications which are not at all essential to this discussion, recoup all losses that may be sustained at the comparatively few points, and in carrying the relatively unimportant traffic, with regard to which there is actual competition. The inevitable result is that whatever reductions may be made at the points where true competition exists operate as unjust discriminations against the points having but one available line, while the unnecessary expenses entailed in keeping up this competition must be borne by enhanced average rates.

STANDARDS OF PRACTICE IN ELECTRIC-ELEVATOR INSTALLATION.

By Percival Robert Moses.

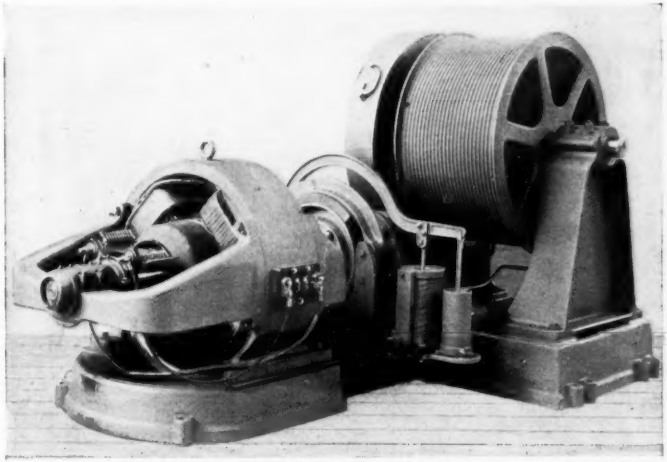
THE questions arising in the design and construction of elevators have received little attention in the technical press,—a surprising omission in view of the number of fatal accidents occurring, the majority of which could be avoided by consideration of elementary mechanical principles. The importance of the subject in the United States is indicated by the fact that there are more than 6,000 elevators in New York city alone, and a low estimate of the car-trips made per day is more than 500,000; while the passengers certainly outnumber those carried by the street and elevated railroads combined. The growth of this branch of the industry can be compared only to that of the "trolley." From barely 3,000 h. p. on the central-station service in 1894 the number has increased until there are now more than 10,000 h. p. installed. The elevators operated from isolated building plants probably bring the total to nearly 20,000 h. p.

In Great Britain and on the continent the development has barely commenced, but its possibilities are hardly calculable. Experience has shown that facilities for vertical traffic are the direct result of increased means of rapid transit on the level. While business men were restricted to the slow-moving horse-car or cab, business interests were scattered; the ship-owner had his office at the dock, the lawyer was at the courts, and the manufacturer at his factory; as a consequence, the building of five stories fulfilled all requirements, and the lift was a luxury. The advent of comfortable rapid transit and the telephone changes these conditions; the separate trades draw close to each other by means of business offices in the city, and the ensuing contraction causes the high building to spring up and the lift to become a necessary tool in the "manufacture of transportation." The new electric underground railroads in London will lead to the building of tall buildings of twelve stories and upward, notwithstanding the present laws, as the elevated railroads have already done in New York and Chicago. That the elevators used in these and smaller buildings will be operated by electric motors there can be but little doubt, and a study of the actual conditions will not be out of place. The mechanical problems encountered and overcome are more severe than those of street railroads; the elevator car



HIGH-SPEED DOUBLE-DECK SCREW MACHINES FOR HORIZONTAL INSTALLATION.
Manufactured by Sprague Electric Company.

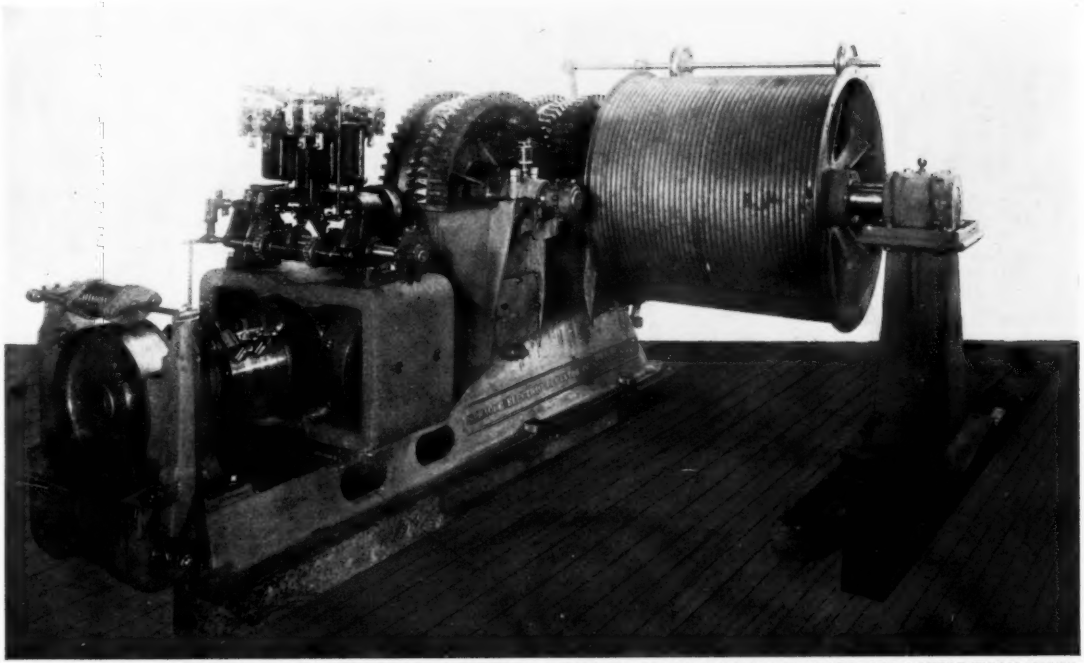
runs on a hundred per cent. grade, is able to attain a speed of 600 feet a minute without jerking, in about a second and a quarter, and may be stopped in the same manner and time. It must be capable of continuous operation, as there is no car-barn into which it can be run and repaired while another is substituted to do its work. Space is limited, and a shut-down of one elevator out of six in a large office-building is a serious annoyance during the busy hours. Moreover, it must be absolutely safe and easily operated. On the other hand, the advantage of a clean, clear track and continual supervision of the operating mechanism is obtained.



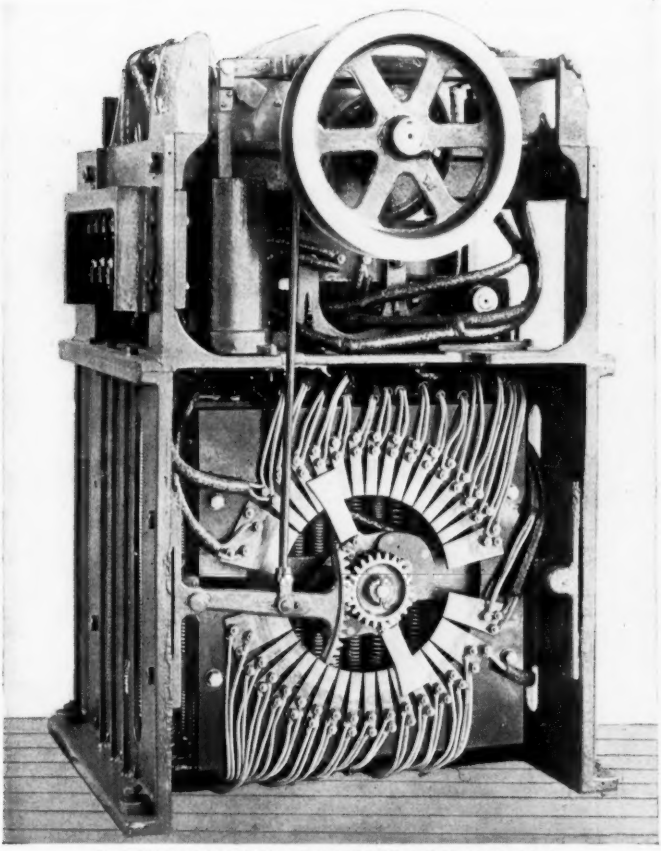
SINGLE WORM-GEAR DRUM ELEVATOR, WITH ELECTRO-MECHANICAL SAFETY BRAKE AND SOLENOID CONTROLLER.

Manufactured by Elektron Elevator Company.

Elevators are divided into those for passengers and those for freight. In the former, three sub-divisions, depending on the speed, may be recognized, *viz.*, high speed, from 300 to 700 feet a minute; medium speed, from 150 to 300 feet; and low speed, or less than 150 feet per minute. With freight elevators only two speeds—medium and low—are necessary; high-speed freight is invariably carried by one of the passenger elevators during slack hours. In general, that passenger-elevator system is the best which gives the greatest speed consistent with safety and comfort at the least cost of operation and maintenance. The most efficient freight system is the one which transfers greatest loads quickest at the least cost of operation and maintenance.



TANDEM WORM-GEAR DRUM ELEVATOR WITH ELECTRIC CONTROL, INTERLOCKING AUXILIARY SPUR-GEARS, AND DOUBLE WORM GEARS.
Manufactured by the Sprague Electric Co.

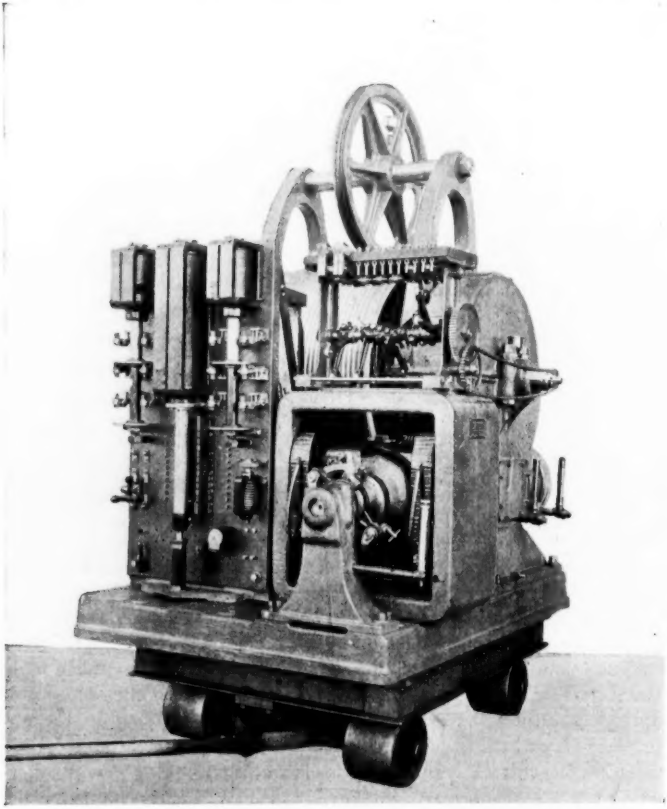


SOLENOID CONTROLLER OF ELEKTRON WORM-GEAR DRUM.

To meet the varying requirements of speed and load three types of electric elevator have been perfected, and numerous others advocated. The three are the screw with multiple sheaves, the double worm-gear drum, and the single worm-gear drum. The methods of operation of the last two are similar, the difference lying in the absence of all end thrust and increase of bearing surface with the double machine due to two worms and wheels and interlocking gears; otherwise each has an electric motor keyed to a shaft directly coupled to the worm shaft, which operates a large worm wheel directly attached to a

drum on which the car and counterweight ropes wind, transmitting movement to the car. Motion is arrested by removal of power and by application of brake on the motor shaft or closing of the motor circuit through a resistance, causing work to be done by the car or by both.

The screw type was built to compete with the high-speed hydraulic, and closely resembles it in many characteristics. Like the ordinary hydraulic elevator, it is constructed for either horizontal or vertical installation; transforms power at low speed into power at high speed by nests of sheaves and a sheave on the counterweight;



AUTOMATIC HOUSE-ELEVATOR, WITH PUSH-BUTTON AND SOLENOID CONTROL.
Manufactured by Sprague Electric Company.

has absolute and fixed limits of travel; raises the car by power, and lowers it by gravity; has a fixed lead of the ropes in the hoist-way; and allows of equalization of their work at the machine. These factors are of great importance for all high-speed work. The method of operation is as follows: power is delivered to an electric motor coupled to a forged-steel screw; rotary motion of the screw transmits lateral motion to a travelling cross-head, by a so-called frictionless ball-bearing nut, to which is attached a nest of sheaves. Ropes from the car (or counterweight) travel over these sheaves and a stationary set (at the end of the machine away from the motor), multiplying the velocity of the nut eight to ten times. Motion is arrested as in the drum machine, but the action is assisted by gravity instead of being impeded.

ROPE MULTIPLYING GEAR FOR ELECTRIC ELEVATORS.

The car is caused to lower by the attraction of gravity, the speed being regulated by a variable resistance in the main circuit, forcing the descending elevator to do work in direct proportion to the amount of power given out by the motor, which, by reversal of conditions, has become a dynamo.

Designing an elevator installation demands the consideration of a number of points, among which are the class of travel, distance between floors, available space, labor, and power, heating system (in old buildings), probable ratio of maximum to average load, continuity of service, and legal restrictions.

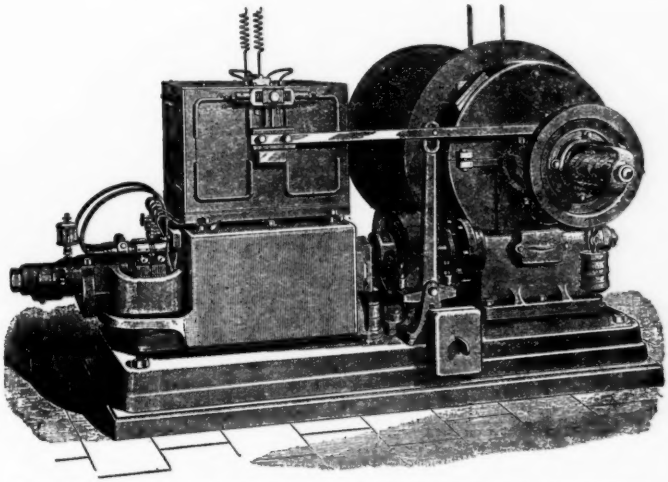
For example, an apartment-house seven stories high, containing women and children, and in which the service is intermittent and moderate, requires a different type of elevator from that necessary for a transient hotel, which, in turn, has needs differing from those of a loft or office-building.

The distance between floors affects the permissible speed without absolutely determining it; a small available space means few cars at high speed with skilled operators; the availability of power from a central station determines, in small buildings, the question of the motive power used; the heating system affects the type of engine or pump employed; the relation of average to maximum load indicates the amount of overbalance, kind of motive power to be used, and the rating of the machinery in h. p.; and continuity of service bears on these points,

and on the source, as distinguished from the kind, of power as well. Legal restrictions vary in different communities, but relate generally to questions of safety, and not to the type or kind of machine to be employed.

The question of prime importance in elevator-design is that of safety. Economy of operation and ease of control are large factors, but, no matter what else may have to be sacrificed, human life must be secured. Accidents may occur either from carelessness or from faulty design. The former may be guarded against, but not absolutely prevented; for the latter there is no excuse. A system, to be absolutely safe, should include apparatus for preventing a drop, should all the ropes break at once, or, if one should fail, for preventing abnormal speed due to excessive load or other cause; for holding the car stationary on the removal of power, or under any possible conditions of overload; for absolutely arresting the motion of the hoisting machine, and for removal of power when the car approaches the limits of travel; for immediate removal of power from the hoisting machine in emergency, if the cables slacken or in case of temporary cessation of supply; for receiving and stopping the car and the counterweight, should all the other devices fail to operate; for prevention of operation until hoistway doors are actually closed. The last condition is rarely fulfilled, the automatic house machine being alone in its compliance. Speed is of sufficient importance in the majority of cases to offset the results of possible carelessness on the part of the operator. In addition to the apparatus above mentioned, the cables for hoisting, the safety clutch for gripping the rails, the sheaves, bearing, and, in fact, all vital parts, should be of a strength far in excess of average actual requirements. This strength costs little and is of great importance. Easy, reliable control and economical operation are in a degree opposed, if the fixed charges are included in the latter. An ideally-controlled elevator would be capable of starting the car from rest with uniformly and rapidly accelerated velocity and minimum waste of power, of running the car at varying speeds, and of arresting motion, easily for ordinary stops, and immediately for emergencies. It would be noiseless, simple, and absolutely reliable in its action, and, in case of accident or carelessness of operator, should automatically stop the car. It would be so designed and constructed as to preclude accident, no matter what the operator might attempt to do. These conditions are hard to realize completely in one system, but they have been partly fulfilled by several. Two general methods of control are recognized. The first allows of varying the speed from the car; the second does not, except for starting and stopping. The object of the first method is obtained in two ways: by a pilot motor

operating to vary resistance in the main circuit, as in the Sprague system, with an inverse variation of the motor field strength; and the variable voltage, or Leonard, control, where each elevator motor has a separate generator, and the speed of the car changes in accordance with the varying electric pressure of the generator. This pressure is determined by a resistance in series with the small field current, and is adjusted from the car. Both methods meet most of the conditions imposed, and the question of choice for all speeds of less than 350 feet per minute is one of comparative economy. The Leonard system is employed only for worm-gear machines, and could not be operated



SINGLE WORM-GEAR DRUM ELEVATOR WITH ELECTRO-MECHANICAL CONTROLLER.
Manufactured by Otis Elevator Co.

with the present make of screw and multiple sheave machine. The variable voltage system allows of an ideal start and stop, whether from the standpoint of economy or from that of comfort; on the other hand, from the point of total economy in operation, the rheostat control is advisable because of the necessarily continuous operation, and the first cost of a separate generator for each machine. The proportion of time during which a car is in actual motion varies with the class of travel, but even in ordinary office-buildings it rarely exceeds five-eighths, and generally falls below one-half of the total operating period. In addition, each generator must be of capacity sufficient for the maximum starting load, and consequently runs at low efficiency.

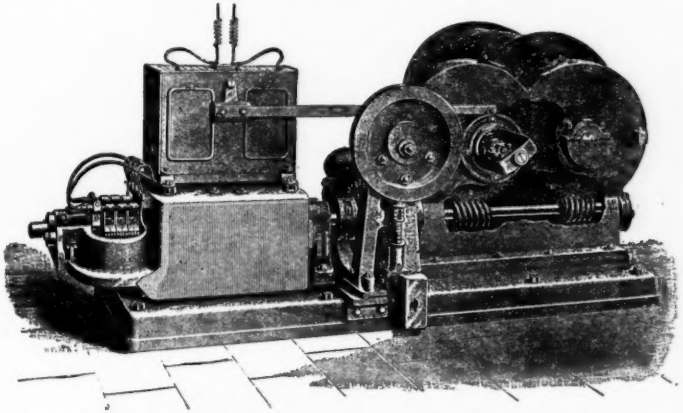
In this connection the following data from seventeen elevators, taken at random from more than a hundred tests, is of interest. The speed varied from 60 to 450 feet per minute, the maximum capacities from 1,500 pounds to 3,000, the maximum live load was 1,600 pounds, the minimum 150 pounds, and the average only 593 pounds. A test on a tall office-building showed the average load to be less than one-seventh of the maximum, and the figures on another, where the elevators were apparently worked to their fullest capacity, showed it to be less than one-fifth. In general, the average live load varies from one-fifth to one eighth of the maximum. As far as statistics show, the variable voltage system is less economical and simple than the ordinary rheostat control when applied to worm-gear machines; in smoothness of starting and operation it is superior. For low-speed machines, or for buildings where variable speed is not essential, a solenoid control answers all purposes, and its operation may be controlled directly by electricity from the car, or the shipper rope and wheel may be employed to close switches on the machine and operate the brake.

House elevators have an automatic control, which includes the following features: push button, or buttons, on each floor to bring the car to the landing; automatic locks, to prevent opening of the door except when the car is about level with the floor; door switches, stopping the car if door is opened; and a device preventing the operation or calling of the elevator by more than one person at a time. This control works with complete safety and satisfaction with the various parts strongly and mechanically made. Small spring and trigger attachments are to be avoided, positive action, controlled electrically or mechanically, being substituted. Stopping the car is an important branch of the control, and is accomplished by removal of power, brake and short circuiting for heavy loads, and by the first and either of the other two for light loads. The difficulties are apparent; a car must be brought to rest within a few feet under widely-differing conditions of speed and load, and this involves as well the stoppage of the hoisting machine, the counterweight, and the sheaves. For this reason with heavy loads a device compelling the car to do work in stopping is almost a necessity for safe and easy operation. For very-high speed machines still another device is used, which allows the brake band to touch the pulley just before stopping, causing the car to perform direct mechanical work, in addition to the electrical work caused by short circuiting.

The use of a brake depends largely on the construction of the worm gear. If this is of such nature as to allow a loaded car to reverse its motion, a brake is a necessity for holding the elevator in position. If the gear will reverse only when actuated by the motor,

the brake becomes an emergency stop, and short circuiting, combined with the friction of the worm, is relied upon for ordinary occasions. This latter method involves the use of a worm gear with a more acute angle of contact, entailing increased friction and decreased efficiency, and requires a larger current for the down start and running. It has, however, an added element of safety.

Correct counterbalancing has an important bearing on the successful operation of the car. Efficiency and ease of running are in a degree opposed. Theoretically that system will be under the best control which has the least inertia ; hence the use of a counterweight tends to reduce the certainty of control, and this result increases with



DOUBLE WORM-GEAR DRUM ELEVATOR WITH ELECTRO-MECHANICAL CONTROLLER AND INTERLOCKING WORM-WHEELS.

Manufactured by Otis Elevator Co.

the speed. Practice has shown, however, that, so long as the car exerts one-quarter to one-half more downward force than the counterweight, no trouble need be feared. With the drum machine and a speed of 350 feet a minute or less, two counterweights may be employed, the car counterweight exerting two-thirds as much force as the car unloaded, and the drum counterweight, the ropes of which wind on the drum in an opposite direction to the car ropes, exerting a force equal to that due to the unbalanced weight of the car and to the average load. Where lights or motors are to be supplied from the generators that supply the elevators, the question of economical operation gives precedence to steadiness of pressure, and it may prove advisable to have the counterweight balance one-half the maximum load. In high buildings a varying counterweight must also be

employed to allow for the change in the force exerted by the ropes, as the car moves up and down the shaft, and for the decrease in load in the upper portion of the building. This variable counterweight is a heavy chain, attached at one end to the bottom of the car, and at the other to the counterweight, or to an anchorage in the hoistway. With high-speed service the car should descend by its own weight, and should never be overbalanced. A system involving the opposite principle—*i.e.*, a counterweight exerting a force greater than the car fully loaded—is in use, and should be condemned. The inertia of the system is nearly doubled, and, in case of accident and failure of safeties, the ropes are sure to break with the car at the top, dropping it the whole height of the building. With reduction of inertia in view, the counterweight for high-speed cars moves at only one-half or one-third the velocity of the car, the weight being increased in proportion. This reduces the total inertia of the system, and, in addition, decreases the cost of the counterweight guides and ropes.

The proper speed for a given building is one which will enable a trip up or down to be made in half a minute without stops. This figure will be modified to a certain extent by local conditions, but is a rough approximation. Apparently the speed should depend on the number of passengers to be carried, but this varying condition must be met by the size of the car, as there are certain periods of the day when the tenants all move, and high speed is of no advantage. Express elevators to the upper half or third of a tall building have been used with doubtful success. Crowding out of lower-floor tenants is almost prevented, but a number of annoying features have arisen, such as restriction of ease of intercommunication, mistakes in cars, etc. In addition, during all but the "rush" hours two cars are fulfilling the duty of one. Velocity of service is increased by floor calls and indicators showing the position of the cars. Variable speed is a necessity where the cars are required to run at certain distances apart, or where elevators are run from a lighting plant.

For high buildings, with elevators running from 350 to 700 feet per minute, the increase in the inertia of the system and in the probable and possible strains due to sudden stoppage must be met by increased cable strength, fixed and absolute limits of travel, an underbalanced car with a counterweight moving at one-half or one-third its speed, etc. These conditions are filled only by the hydraulic and screw electric machines. The worm-gear drum machine is unfitted for such work, as it has an endless character of movement, and can not have double or triple ropes on the drum, on account of the size of drum necessary and the impossibility of equalizing their work at the machine.

With the screw and ball nut type multiplication of the speed is effected by multiple sheaves on the nut; the ropes from the last of these sheaves are attached to the bottom of the counterweight. From an anchorage at the top of the shaft other ropes pass around a sheave fastened to the top of the counterweight, and thence over and around the overhead sheaves to the car. Short distances between floors and the necessity for a quick stop indicate probable limits of multiplication. An interval of one second with the screw turning 250 times per minute would carry the car 8⅓ feet in a second, with a multiplication of 20 to 1. The practical limit lies at about these figures, and higher car speed must be obtained by increasing that of the machine. For buildings with elevators running from 150 to 350 feet per minute the double worm-gear drum elevator satisfies all requirements. In this the speed is varied by the ratio of the worm wheel to the worm, and by the size of the drum. Up to a certain limit, with a worm of given size, the greater the ratio, the more economical is the operation of the gear and of the electric motor due to the decreased angle of contact, decreased friction at high speed, and electrical losses. By increasing the diameter of a worm, the path travelled by the point of contact with the wheel is increased, and the angle of contact decreased for a given pitch, rendering a reversal of rotation of the worm by the car more difficult. However, more surface is obtained if the gears are correctly cut and variation in speed and work is more gradual. Consequently heavy loads require large worms. The limit of multiplication is fixed by the size of the drum, which, in turn, is determined largely by the height of the hoistway, and in some cases by the space allotted to the elevator machinery. For residences, apartment-houses, and sidewalk hoists, requiring speeds of 150 feet per minute or less, the single worm-gear drum is used exclusively, and is operated by a solenoid or by automatic control. As these machines receive little or no care, they must be simple and automatic in their action, and at the same time be capable of receiving bad treatment without injury: hence self-oiling bearings, self-cleaning switches, enclosed motors and parts, and magnetic blow-outs or other arc arresters are desirable. Where the car is run but seldom, it may be advisable to counterweight for one-half the maximum load, in order to decrease first cost of the motor; but the question is not of importance. The requirements of the motors for all the three types are strength, sparkless commutation with all loads and speeds, ventilated armatures, careful securing of lugs, commutator bars, and winding, and avoidance of sharp corners, fields variable and balanced, etc. Devices for opening and closing the circuit without destructive arcing involve either the magnetic blow-out or the divided arc principle for

all heavy work. For light loads a quick, long break answers all purposes. In general, high speed is not advisable or essential. The hoistway should be of a fire-proof material and covered by a skylight, with a screen placed immediately below the overhead machinery. Ample room above and below the car at its limits of travel, to provide for possible slip or stretch in the ropes, should be allowed. If grill work is used, a simple, open pattern, giving a clear view of the landings, is most satisfactory to the operator, and may be made entirely safe.

Operation of elevators from the lighting engine is frequently desirable; with overbalanced machines carrying moderate loads this can be accomplished by adopting a slow starting device or by running the generator below its rated output. In either case, even with perfect engine-regulation, a flicker in the lights will occur, due to the electrical reaction of the varying current. With underbalanced machines the flicker is more noticeable and can be removed only by the employment of a separate generator for power—coupled or belted to the lighting engine, or by the use of storage batteries in connection with a booste motor-dynamo.

Where a number of worm-gear elevators are installed, a large economy results from the balancing action of the descending elevators, which return current to the source, aiding those ascending.

The cost of electric-elevator operation is lower than that of any other practical method. The power required per car-mile in office-buildings varies from 2 kilowatt hours (with the overbalanced worm gear) to 4 kilowatt hours (with the underbalanced screw). Approximate costs on the central service at 10 cents per h.-p. hour for small, and 10 cents per kilowatt hour for large, consumers are $3 to $10 for residences, $10 to $20 for apartment-houses, $15 to $40 for loft and small office-buildings, and $40 to $90 for tall office-buildings, per month.

In conclusion, an answer to the question so often advanced: "Are electric elevators safe and reliable?" will not be unfitting. Electric elevators are the safest vehicles to travel in known to humanity; none have ever fallen, nor have people been killed by them except through their own carelessness,—a remarkable record considering the novelty and number of machines installed. Like the motor of the trolley car, they run in positions apparently ruinous to fine machinery—such as buildings half completed and damp holes,—without serious damage; they require but little attention, oiling and cleaning being necessary only once or twice a day, and are highly efficient.

REVIEW OF THE ENGINEERING PRESS

CONTENTS.

ARCHITECTURE AND BUILDING.

Esthetics of Bridge Design 494
National Style in Architecture 501

CIVIL ENGINEERING.

The Hemet Dam 497
An Important Bridge Replacement.....500
The Colombo Harbor Works..... 507
Improvements at the Mouth of the Loire .509
Recent German Bridges.....513
The Eckmühl Lighthouse 514
The Caissons of the Alexander III Bridge 515

ECONOMICS AND INDUSTRY.

Labor-Saving Machinery.....501
Technical Education and Foreign Competition 504
The Stockholm Exposition.....510
Old Paper 511

ELECTRICAL ENGINEERING.

Electricity as a Source of Heat.....497
The Equalization of Electrical Energy...499

MARINE ENGINEERING.

The Speed Trials of the Powerful 502

MECHANICAL ENGINEERING.

Steam Boiler Efficiency ... .496
The Sand Blast for Cleaning Metal.....500
Wire-Drawn Steam..... ..503
Mechanical Recording Apparatus.....516

MINING AND METALLURGY.

Gold Placers and Lodes..... . ..495
The Ventilation of Mines.....508
Chinese Mining Communities.... 510
Portable Bulkheads for Mines.....514

MUNICIPAL ENGINEERING.

Garbage Disposal 493
Gas and Electricity.....503
Paris Sewer Construction.....512

RAILROAD AFFAIRS.

Historical Locomotives 495
The Federal Coupler Law.....498
Railroad Building in South Africa.....505

STREET AND ELECTRIC RAILWAYS.

Electricity on the London Underground..506

Garbage Disposal.

THE interest which attaches at the present time to the question of the complete and economical disposition of garbage renders every reliable account of successful practice important, either for purpose of comparison or of imitation, and hence the very complete paper upon the garbage disposal works at Hamburg, by Mr. Rudolph Hering in the *Engineering Record* (October 23), is to be welcomed, especially as this is the largest single plant in any city up to the present time.

It is now one year since these works have been in operation, and the careful records which have been kept enable definite information to be obtained concerning the operative and financial success attained.

The plant is designed to provide for the incineration of the garbage and refuse from a population of 300,000 persons, and, after some consideration, it was decided to use furnaces of the Horsfall, Warner, and Whiley systems, following generally the English designs, with some modifications due to local conditions. As the Horsfall and the Warner furnaces were to be used in a similar plant at Berlin, the Warner furnace was replaced by the Whiley system at Hamburg. The Horsfall cells were arranged for hand-firing, with steam jet blast under the grates, while the Whiley system included moving grates, by which the drying and burning refuse was to be moved forward automatically. In practice, however, it has been found better to substitute air blast in the one case for steam, and hand-stoking for automatic action in the other, and with these modifications the plant has been operated since April, 1896.

The general arrangement of the plant is very fully shown in Mr. Hering's article, together with the electric cranes by which the iron tank bodies of the collecting carts are handled and the garbage dumped at the furnaces. There are thirty-

six furnaces, or cells, arranged in two rows, so that either half of the plant can be used separately, one tall chimney answering for both sets of furnaces. The natural draft of the chimney is aided by an undergrate air-blower, and, after the combustion is started, no coal is required to assist in the complete incineration of the refuse. An auxiliary grate-furnace for coal is provided to get up steam in the boilers and start the blowers, after which all the heat for the generation of steam necessary for the operation of the blast, and the production of electricity for the cranes and for lighting is produced by the combustion of the garbage.

The clinker and ash produced in the furnaces is cooled, broken and crushed, and sold for road-making and for the manufacture of concrete slabs, the demand thus far exceeding the supply.

The works have proved entirely unobjectionable to the surrounding neighborhood, no offensive smoke or odors being produced. The cost of the entire plant is given as $120,000, the capacity being 78,876 metric tons per year of 313 working days. Taking into account interest on cost, and also sinking fund and maintenance, and deducting for sale of refuse, the cost for the past year has been 35 cents per metric ton (practically an English long ton), and, when the preparations for fully utilizing the heat are completed, this will be reduced to 21 cents per ton.

Mr. Hering's paper is full of valuable detailed information, which cannot fail to be of much use in the United States.

The Esthetics of Bridge-Design.

THE charge has often been made that engineering works are in themselves ugly, and very often are made still more unsightly by clumsy attempts to decorate them. It is, however, by no means the fact that utility and ugliness are necessarily companions, and a well-proportioned structure may contain within its own lines the elements of beauty to almost as great an extent as does an architectural masterpiece.

Mr. Alfred P. Boller, the well-known engineer, has contributed to *Engineering News* (October 7) an article upon the subject of the esthetics of bridge-design, choosing as texts, so to speak, for his discourse two bridges recently completed in New York city; incidentally he brings out many points which need emphasizing so far as many other engineering structures are concerned. As Mr. Boller truly says, "the splendor of a city is made by its architecture in the broadest sense of the term, which is its outward and visible form, and, when there are waterways demanding bridge crossings, such crossings should be studied on architectural principles, as well as those of purely constructive engineering."

After defining good architecture under the three ultimate heads of fitness, stability, and beauty, Mr. Boller notes that the first two of these are essentially engineering demands, and must necessarily appear in engineering structures, but that the last requires for its realization an entirely different mental equipment, involving both a familiarity with admitted types of pleasing and attractive forms, and an appreciation of the thought behind them and their underlying principles.

While there are no empirical rules for beauty, there is yet an intuitive development of public taste based upon contact and association with the works of great designers, and the principles beneath all really artistic designs apply as well to bridges as to other structures. Applied ornament has its place, as in general architecture, and should be used most sparingly, the best rule being the old saying: "Decorate construction, but do not construct decoration."

This is especially true of bridges, which, as a rule, are seen at a distance, and to which character is given by mass and general proportions. It is only under close inspection, when the effect of the whole is lost, that detail can be grasped, "but the lines and masses, the relations of the units to each other, such as proportions of piers and spans, down to subordinate relations of railing and cornice, are what give character to such structures."

The ideal basis for a beautiful structure is the arch, whether in thrust or in ten-

sion, and it should always be adopted when artistic effect is demanded and structural conditions will permit. On important waterways, however, the use of the arch is rarely possible, and girder forms must be adopted as constructive necessities, usually also with draw or swing spans.

In both of the bridges reviewed by Mr. Boller, the latter form was of necessity adopted, and in both he has endeavored to embody the principles of architectural bridge-design on the lines indicated in his article. While the limitations of construction hampered the artistic side of the work materially, there is no doubt that both the Ship Canal bridge and the Central bridge over the Harlem, of which illustrations are given in *Engineering News*, show abundant evidence of earnest effort to raise the art of the bridge-builder to a higher plane than that of a mere constructor, and a fair measure of realization of the true artistic combination of fitness, stability, and beauty.

Gold Placers and Lodes.

THE richness of the Alaskan gold placers has led to some discussion as to the possibility of the discovery of the lodes from which presumably the placer gold has been eroded, and in this connection the *Engineering and Mining Journal* (October 16) gives some valuable remarks about the relations of placers and lodes, which are very pertinent at the present time.

It is generally assumed that rich placers mean rich lodes somewhere behind them, and that exploration will reveal the sources of the gold in even greater quantity than the gravel and alluvial deposits of the streams and valleys. This, however, is not necessarily the case. It is true that a placer is a natural concentration of mineral which once existed in solid rock, but this concentration may have originated in many veinlets so small as to be unworkable in themselves, or the parent lode may have been eroded entirely, and be no longer in existence.

Sometimes also the auriferous *débris* have been carried so far, by glacial action, that no connection between placer and lode can be established.

These views are supported by the history of some famous placers, those of Breckenridge, Colo., of Leadville, of the American river, in California, and others, being cited to show that, when the veins were successfully traced from the placers, the resulting quartz mines were by no means so rich as might have been inferred.

The reverse has also yet to be established,—*viz.*, that placers of value should accompany rich lodes,—and in the cases of the great quartz veins of Grass Valley, Nevada City, and the rest of the Mother Lode no placers of great importance were found.

In concluding, the writer applies existing experience to the Klondike placers as follows;

"Although the evidence of direct connection between the richest placers and the richest lodes is largely negative, it does not follow that where the former are found the latter should not be looked for, and the fact remains that the two classes of deposits commonly occur in the same region. There is much reason to expect, therefore, that many lodes will be found, sooner or later, in the Yukon country, but their discovery may not be so simple a matter as is supposed by many who seem to believe that all that is necessary is to follow the gold-bearing creeks to their heads to find the mother lodes from which the alluvial deposits have sprung out."

Historical Locomotives.

THOSE who had the privilege of inspecting the notable exhibit of the Baltimore & Ohio Railroad Company at Chicago in 1893 then realized what an interesting place in mechanical history was filled by that array of locomotives of successive periods and builders.

The *Railroad Gazette* (October 22) now calls attention to the fact that this important exhibit of full-size models and actual engines forms the nucleus of the still more complete collection in the Field Columbian Museum, at Chicago. Many of these engines are but models, reproduced from

old drawings, fragments, and other data, but there are not less than fifteen original locomotives of the types used between 1832 and 1876, and the collection far surpasses in completeness and value the one at South Kensington Museum in London.

The Field Museum also contains the very valuable collection of drawings, tracings, and sketches of locomotives made in England, these having been acquired by the energetic efforts of the Baltimore & Ohio officials in 1893. These contain many originals of engines built by Stephenson, Bury, and others, and at present no such collection exists anywhere else in the world.

As the *Railroad Gazette* remarks, "we have a more complete set of drawings of historical English engines than can be found in any one place in England, so that, if Englishmen wish to know the full locomotive history of their country, they will have to journey to Chicago for the information."

Steam-Boiler Efficiency.

THERE is a growing disposition on the part both of engineers and of manufacturers to demand efficiency tests of steam-boilers, and performances on this basis are frequently demanded in specifications. Under these circumstances the question of the exact meaning of the term "efficiency." as applied to a steam-boiler, is a matter of importance, and its definition should be clearly understood.

A paper by Mr. V. C. Gasche, read before the Western Society of Engineers, and published in the *Transactions* of that Society (August, 1897), discusses at some length the causes of the variable efficiency of steam-boilers and their influence upon tests, and shows the lack of definiteness in the present usage of the term efficiency.

Usually the "efficiency" of a steam-boiler is considered to be the ratio of the actual to the theoretical evaporation, the theoretical evaporation being understood to mean that which would have been attained had all the heat generated by the complete combustion of the fuel been transferred to the water and the steam. Another, and more recent, definition of the efficiency of a steam generator is the ratio of the heat units absorbed to the total heat equivalent of the fuel expressed in British thermal units.

These both seem definite enough, and, in view of the precision with which all the data of a modern boiler test are taken, should apparently give the determination of the efficiency of a given boiler a high degree of accuracy. In practice, however, successive trials often show remarkable variations of efficiency, though boiler, fuel, and surrounding conditions are the same. The cause of these variations Mr. Gasche finds in the influence of the rate of combustion of the fuel. The thermal unit is undoubtedly a constant quantity, but the variable resistance of materials to the transfer of heat introduces the time element.

Mr. Gasche very correctly insists that a boiler trial is essentially a measurement of rates.

"The ultimate result depends on rate of delivery, of feed water, rate of coal consumption, and rate of ejection of moisture with the steam. The first requisite for the measurement of these rates is to maintain constant the conditions upon which the operation of the boiler depends, meaning, among other things, that the demands for steam from a boiler under test must be maintained as nearly uniform as it is possible to make them."

By means of diagrams plotted from data of various boiler tests, it is shown that Rankine's analytical formula for the determination of efficiency from given conditions expresses the law of variation of boiler efficiency, and, by comparison between the computed evaporation and the actual determinations from sixteen typical boiler trials selected from one hundred and sixty tests, the important influence of the rate of combustion upon the efficiency is shown.

It is most undoubtedly desirable to maintain all conditions as nearly uniform as possible during a boiler test, and the especial importance of the uniformity in the rate of combustion is well brought out in this paper. The flying start and finish, even though involving an estimate of the difference in the quality of coal on

the grate at the beginning and end of the trial, appears to permit a more uniform maintenance of rate of combustion than is possible by withdrawing the fuel on the grate and making a fresh start. A similar occasion for variation appears in the practice of allowing the fires to burn out at the close of the trial.

In view of the possible sources of variation of efficiency in the performance of the same boiler when the conditions of combustion are varied, it certainly seems advisable that the same conditions should be observed, so far as possible, in comparative tests of boilers of different construction, and Mr. Gasche has done well in calling attention to the sources of discrepancy.

Electricity as a Source of Heat.

MONTREAL is now supplied with electric current from two natural sources of power, one operated by the Chambly Manufacturing Company and utilizing the rapids of the Richelieu river, the other being the great power plant of the Lachine rapids on the St. Lawrence. To describe either in detail would be but to repeat accounts of turbines, generators, and transmission which have already appeared in other places, notably in the *Electrical World* (October 2 and 9); but some of the especial points of interest may be noted here.

Two features of discussion in the Montreal plant are somewhat local and climatic; one the problem of coping with the anchor ice and gorges; the other the proposition to use electric current generally as a source of heat. Of course, electric heating is, in itself, nothing new; but at Montreal it is seriously proposed by the electric company to attempt to compete with anthracite coal in the matter of domestic heating. Coal for household purposes at Montreal costs six dollars a ton, and it is claimed that the cheapness with which current can be obtained will permit electricity to be used for cooking and warming, through the Canadian winter, advantageously, as compared with fuel.

In an editorial in the *Electrical World* the computation of the equivalent cost per heat unit, with coal at six dollars per ton, is made as follows:

"A theoretical determination of the heat obtainable from coal and from electrical energy indicates that the rate per kilowatt-hour will have to be made extremely low to compete with coal at such a price. Anthracite coal gives off, in burning, approximately 15,000 British thermal units per pound. Allowing for a loss of 50 per cent. from incomplete combustion and flue losses, electrical energy would have to be sold at the rate of fifteen one-hundredths of one cent per kilowatt-hour to make the cost per heat unit the same as that derived from six-dollar coal."

Should this experiment, made on so large a scale and in so exacting a climate, prove successful, it will doubtless encourage other attempts to convert hydraulic into thermal energy, the more so when it is remembered that some of the greatest sources of water power are found in localities in which fuel is both scarce and dear.

The Hemet Dam.

THE subject of the design and construction of masonry dams is one which at the present time is receiving renewed attention, and this for several reasons. In one part of the United States water is being impounded for purposes of irrigation; in another, water power is applied to the economical generation of electricity; while, on both sides of the ocean, the disastrous failure of large dams, releasing enormous volumes of water, has caused active discussion as to questions of detail in form and construction, both as regards safety and economy.

California contains a large number of important high masonry dams of recent construction, and one of the most important of these, the Hemet Dam, is very fully described by Mr. James D. Schuyler, by whom it was planned and supervised, in a paper read before the Technical Society of the Pacific Coast, and published in the *Journal of the Association of Engineering Societies* (September, 1897).

The Hemet dam is noteworthy both on account of its height, 122.5 feet, with a possible extension to 150 feet, and for the

care given to its design. The general theory of dam construction includes two forms,—the arch, and the gravity form. One of the most important California dams, the famous Bear Valley Dam, depends wholly upon its arch form for its stability, and it was at first proposed to construct the Hemet dam of a uniform thickness of four feet, with an arch curvature up stream of the shortest possible radius. Fortunately, however, wiser counsels prevailed, and the present dam combines both the arch form and a profile of the gravity type, thus possessing the advantages of both forms. This construction was the more practicable because of the favorable nature of the location, the dam being situated at the head of a narrow granite cañon, with solid bed-rock foundation, with abundance of sand and rock for construction at hand, the cement being the only material brought from a distance.

The methods used in the construction work were modern and effective, two cableways being used to handle the heavy blocks of stone, taking them from the banks and delivering them to derricks mounted on the dam. The power for hoisting and handling was obtained from a Pelton wheel driven by water brought in a temporary flume, the stream thus being compelled to work its own confinement; and the same power was used to operate the mortar and concrete mixers. Rock-crushers and -conveyors were also used in the preparation of the concrete, and the general plant was so arranged that unskilled laborers were able to perform most of the work.

The dam is 100 feet thick at the base, and 30 feet thick at a point 110 feet above the base, at which point the wall is reduced to 12 feet. The profile is so drawn that the line of pressure with full reservoir falls just outside the inner third of the base at all points, thus conforming to the theoretical requirements for stability, while the additional strength due to the curved shape gives a still greater measure of security. Another important point in favor of the curved shape, urged by Mr. Schuyler, is that advanced by Professor Forchheimer, as to the ability of a curved dam to permit the motion due to expansion and contraction from temperature and shrinkage, without the formation of cracks. Unless some such provision is made, a tension stress greater than the cement is capable of resisting may be brought upon the masonry, altogether independently of the hydrostatic action.

The reservoir formed by the Hemet dam, as at present completed to the 122.5 height, has a capacity of 10,500 acre-feet, or 3,430,000,000 gallons, and, by carrying the dam to the 150-foot contour, this would be increased nearly two and a half times. At its present capacity the reservoir is capable of providing sufficient water for the irrigation of 5,250 acres.

In view of the increasing importance of dam construction in various localities, Mr. Schuyler's paper is of much value, and should be consulted by all interested as a record of a work of great magnitude and importance.

The Federal Coupler Law.

UNLESS relief or extension of time is granted by the interstate commission, all the railroads of the country must have their freight cars equipped with automatic couplers by January 1, 1898; and in the *Railroad Gazette* (October 15) is an editorial reviewing the progress which various railroads have made in preparing for compliance with the law.

During the past three years the business depression has made it somewhat onerous for many roads to incur the expense involved in the equipment, and, according to a table issued by the interstate commission, but few roads have all their freight cars fitted with couplers as required by law. There has been much progress made, however, and, although not many are entirely equipped, a number of roads have more than 75 per cent. of their cars provided with automatic couplers.

It is interesting to note that the roads which have more nearly placed their equipment in condition to comply with the law by the first of the year are in many cases those of the poorer companies, while many which are good divi-

dend-payers are by no means so far advanced. It is understood that, in applications for an extension of time, each case will be heard on its merits, and no general extension for all roads is to be granted; hence, although the work will not be completed by January 1, the coming year should certainly see hand-coupling of freight cars practically a thing of the past.

Another requirement of the law is that of providing all freight trains with sufficient train-brake equipment to permit the speed to be controlled by the engineman. In this respect the progress of the roads, with few exceptions, has been less satisfactory than in the matter of couplers.

The full compliance with all the requirements of the law should certainly result in great reduction in loss of life and in injuries to train hands, and the final outcome should also be beneficial to the companies from a purely commercial standpoint, when the economy resulting from better and more efficient control shall appear.

The Equalization of Electrical Energy.

STORAGE batteries have been used to a much greater extent in Germany than in the United States for the purpose of equalizing the demands upon generators of electrical energy, this especially being the case in tramway service, where the fluctuations in traffic during different portions of the day are very great. The advantages of this use of accumulators is beginning to be realized more generally, and the storage battery forms a very important portion of the new Hartford Electric Light and Power Plant, described in the *Scientific American* (October 9).

The Hartford plant is a remarkably good instance of the flexibility and controllability of an electrical system. A portion of the current is generated by the water power of the Farmington river, the dam being nearly eleven miles from Hartford. Sixteen hundred horse power is thus obtained, and, after being transformed from 500 to 10,000 volts, is transmitted to the Pearl street station in Hartford at a loss of only about 10 per cent. At this station there is also a 1,600-h. p. Corliss engine, coupled to a 600-kilowatt Westinghouse generator, the engine and generator being connected to opposite ends of a main driving shaft, from which also belts are run to the arc dynamos and the street-railway generators. The 10,000-volt current is reduced here to 2,400 volts, and supplies the alternating light and power system of the city, and is also transmitted to the rotary transformers at the State street station. So much of the current as is not required for these purposes operates, as a motor, the 600-kilowatt machine which is coupled to the end of the line shaft, this being so constructed as to be immediately available, either as a motor or as a generator.

At the State street station is the great storage battery, said to be the largest in the United States, and here the 2,400-volt alternating current is received by rotary transformers and delivered into the storage battery as a 240-volt direct current.

The storage battery contains 130 cells, each containing 31 negative and 30 positive plates, the negative plates being of the chlorid type and the positive plates of the Manchester type of Planté plate. Its capacity is a discharge of 1,700 amperes on each side for five hours.

The results of the general arrangement of the Hartford plant are best shown by the load diagram of the State street station. During the early morning hours the consumption of current is only about 350 amperes, the balance being discharged into the battery for subsequent use. When the heavy demand comes, between 6 and 8.30 A. M., the entire transformer current is required on the lines, while later in the day, until the night demand for light ceases, the lines draw all of their current from the battery, after which the charging of the battery again commences, and the current for the line is drawn from the transformers.

The application of the storage battery for this purpose of equalization is a valuable method of overcoming the irregularity of demand upon an electrical station, either for light or power, and the suc-

cessful working of the Hartford plant should lead to further installations of a similar character.

An Important Bridge Replacement.

THE Pennsylvania Railroad Company has for some time been engaged in adapting various portions of its system to the increased demands of traffic, including the greater weight of engines and rolling stock which has gradually come into use. One of the most important pieces of work in this connection was that of the replacement of the bridge of the New York division over the Schuylkill river at Philadelphia, commonly known as the "connecting bridge."

An excellent account of this skilfully-executed piece of engineering work is given in *Engineering News* (October 21), and the success with which a double-track span of 236 feet was replaced in a few minutes renders the account of much value and interest.

Owing to the elevation of the tracks at this point, some eighty-seven feet above the river, and the unreliable nature of the bottom, it was not considered advisable to construct a temporary turnout bridge, but, instead, the new truss was assembled entire upon false works by the side of the old truss and additional false works were constructed on the other side to receive the old bridge. Both spans were then moved horizontally in a direction transverse to the line of the tracks, during an interval between trains, there being thus no interruption to travel.

By the use of suitable piling, the masonry bridge seat at each pier was provided with a timber extension on both sides, and a system of bed-plates and rollers permitted the transfer of the trusses with no difficulty or delay. So completely had all preparations been made that the actual time occupied in changing spans was only 2 minutes 30 seconds, and the actual time between the last train over the old span and the first over the new span was but 14 minutes.

The new bridge consists of two deck Pratt trusses, the span being 235 feet 7 inches and the depth 25 feet 9 inches. It is a most substantial structure. The old truss was of the Whipple pattern, and was built in 1865, and, although it had been maintained in good condition, it was antiquated in design and unsuited for the increased service. The weight of the new truss is 570 tons, and the total weight to be moved during the transfer, including the old truss, rails, ties, and guards, was about 1,400 tons.

The operation reflects much credit upon the builders, the Edgemoor Bridge Co., and upon the engineering department of the railroad company, by which the transfer was conducted. The method may be adopted in subsequent operations of a similar nature.

The Sand Blast for Cleaning Metal.

THE use of the Tilghman sand blast for cleaning the steel viaduct at One hundred and fifty-fifth street, New York, preparatory to painting, as described in *American Machinist* (September 30), is an application on a large scale of what has been in use in a smaller way for many years. In the treatment of metal by the Bower-Barff process, the continuity of the film of magnetic oxid of iron can be assured only by exposing an absolutely clean surface to the action of the gases. For this purpose the sand blast has been found most efficient, and its action prepares the iron pieces for the oxidizing furnace with a completeness not otherwise possible. The effect upon the appearance of the metal is well described in the article above referred to, the silvery gray color being characteristic; and it is to the action of the sand blast also that the peculiar smooth and velvety touch of Bower-Barff hardware is due.

Doubtless the success of this application of the sand blast for cleaning structural work will be followed by its extension to other lines, and, in view of its long use for smaller work, it is a matter for surprise that the process has not long been used for general metal-cleaning.

THE BRITISH PRESS

National Style in Architecture.

IN the course of the president's address at the Liverpool Architectural Society, the speaker, Mr. W. E. Willink, utters some wise and wholesome truths, of which we have space only for a brief abstract. The entire address will be found in the *Builder* (October 9), and is well worth reading.

After deploring the lack of national style in most modern work, and discussing the vast difference between medieval work, in which all the influences of the time found immediate expression in art and architecture, and modern work, in which some past style is copied or imitated, Mr. Willink compares the French method of censorship with the English freedom.

Where, as in France, there is practically a tribunal of art, there will doubtless be produced a national style, which can be and is polished to an extraordinary degree of refinement. "The points of difference are less marked than the points of resemblance; man can be measured against man by the application of standards which admit of no contradiction."

In England, on the contrary, there is such reverence for liberty that no such interference would be tolerated, and the result is what might almost be termed architectural license. So far as immediate results are concerned, there is little doubt that the introduction of the French method would result in marked improvement, but in the long run there would be, as in France, the great danger that the style would become fossilized, and all life chilled out of the artist. With entire liberty, however, Mr. Willink sees greater future results, both for England and America, in the final outcome of national style:

"Men will rise up, who, though well instructed in all the wisdom of the ancients, are enabled, by their force of character, and the instinct of the true prophet, to seize the various films and threads of truth which are floating at large through the air of design, and weave them into a tissue of beauty and fitness which will recommend itself to the world as that which past generations have longed to see, and still desired when they left the scene. And there are signs of the near approach of this great change. There are now vigorous designers who have thrown away the shell of form and kept the kernel, whose conceptions may shock at first by their originality and daring, but finally please by their conformity with fundamental canons. These men I firmly believe to be the forerunners of a new method of expression, which in its many forms (for we need not fear uniformity in this country) will command the adhesion of all who truly love and appreciate the beautiful."

Labor-Saving Machinery.

THE great dispute in England between the Amalgamated Society of Engineers and the Employers' Federation concerns not only the hours of labor, but also involves the question of the control of machines, and indirectly of the nature of the machines themselves.

This side of the subject is well brought out in an editorial in *Engineering* (October 1), and is of especial interest in this connection, since it emphasizes the great difference between English and American methods, and calls attention to modern automatic machinery and to the methods of operation as well.

The revolution which the introduction of power machinery wrought in manufacturing, and the opposition excited among the workingmen at that time, are matters of history, and the riots of "General" Ludd and his machinery-breakers in the early part of the century were but an expression of the fear of the man for the machine which has appeared again and again at many times and in many places.

To the labor union, the idea of labor is based upon the output which a skilled mechanic can produce with the ordinary tools of his trade that have been in vogue for a number of years, and, as this output is mainly proportional to time, the time-rate of wages and the established working-day are taken as a just measure of the wages to be paid. For non-repetition work, tool-making, repair jobs, and the like, this will probably remain true for a long time, but, in the case of duplicate work, the evolution, not only of special tools, but also of automatic machines, which, within certain limits, can be made special tools, has totally changed the relation between the man and the product. From being a skilled hand-artisan, the man becomes a machine-tender,—almost a mere "stopper and starter,"—while the relation of time to output is entirely altered by the fact that one man can attend a number of machines with decidedly less exertion than the old method involved in the same time, and the speed of operation and perfection of product are vastly greater than before.

What is to be done under this new state of affairs? We have only to look back a little to see that it is not really a new state of affairs, but only a new statement of an old problem, which has worked out its own solution many times before.

It has not always been the workingman who has felt the inconvenient pressure wrought by the development of the mechanical application of inventive genius. The trained knight whose whole life had been given to the skilled profession of arms made a mighty uproar when "villainous saltpeter" placed in the hands of the veriest peasant the power to lay him low, in spite of all rules and precedents. So, too, the monkish penman found all his occupation and most of his power wrested from him by the printer mechanic, untrained according to all custom and theory, but nevertheless most irresistible. But it is unnecessary to rehearse what is too well known already. The laws of evolution hold true in one direction as well as another, and opposition to labor-saving machinery is as futile to-day as it ever has been. The countries with which England must compete—Germany, Belgium, the United States—have accepted the situation; for England to refuse, or even to hesitate too long, means industrial suicide.

As for the mechanic himself, history too must tell him what to do. Has his case been helped or harmed in the past by labor-saving machinery? At first much hardship has been wrought, but in the long run we see more men at work, with better wages and shorter hours. History repeats itself in more ways than one.

Speed Trials of the "Powerful."

THE cruiser Powerful of which illustrations are given in one of the leading articles in this issue, has been put through a series of interesting progressive speed trials in Stokes bay, preparatory to her departure for China, where she is to be stationed, and from a report in *Engineering* (October 15) we abstract the following final data of her performance. These figures, the means of four runs each, furnish valuable data for the construction of a speed curve from which the power required for intermediate speeds may be determined, and the performance is especially interesting in view of the fact that this vessel and her sister ship, the Terrible, are fitted with Belleville water-tube boilers, being the first cruisers of the first-class to be so equipped.

The following table gives the indicated power and logged speed on the successive trials:

Speed of Vessel, Knots	10.591	12.492	14.223	16.206	20.96	22
Indicated Horse Power	2256	3735	5452	8344	18,677	24,763

The displacement at the normal loaded draught of 27 feet is 14,250 tons.

The Powerful is also interesting as being one of the two first-class cruisers to be fitted with water-tube boilers, the Belleville type being used. Details of these boilers are given in the article on water-tube boilers by P. A. Engr. W. M. McFarland, U. S. N., elsewhere in this issue.

The adoption of water-tube boilers for the Powerful and her twin-ship, the Terrible, was the cause of a very animated parliamentary discussion at the time, but the trials have fully confirmed the wisdom of the course, and the results will doubtless lead to the use of water-tube boilers in larger units and for larger vessels, not only in the British navy, but elsewhere.

Gas and Electricity.

ABOUT the year 1877, when the introduction of electricity for household and general lighting became a commercial fact, the well-known "scare" in gas stocks occurred, and for a time it seemed as if much valuable property represented by gas shares had been almost wiped out. Notwithstanding the great development in electricity during the twenty years following, the gas industry to-day is more prosperous than ever, and it seems more than ever as if there was ample room for both gas and electricity, side by side, in widely-varying lines of application.

An interesting review of the progress of gas and electricity is given in the address of Mr. Holliday at the Scarborough meeting of the North of England Gas Managers' Association, printed in the *Journal of Gas Lighting* (October 5). The general progress of gas is shown by a diagram of the varying prices of a provincial gas company between the years 1872–1896, the drop in 1877–78 being well marked and the ups and downs of the stock from 1882 onward being along a generally ascending line, until in 1895 public sales of shares gave a price of 175 as against 143 in 1877 and 125 in 1882. During this entire time the regular dividends had been paid, and the fluctuations and the recovery occurred in the face of the great and steady advance in electric lighting.

Much of this recovery doubtless is due to the use of gas for heating and cooking, and of late also to the improvements in incandescent gas-lighting. The increase in the day-consumption of gas is an excellent indication of the growing use for heat surposes, and the Scarborough tables for July and August show that the day-consumption reached 45 per cent. of the total output of the local gas works. In the field of illumination Mr. Holliday concedes the present superiority of electricity, notwithstanding the advance made by the Welsbach type of burner, and makes a strong plea for improvement in methods of lighting by gas before this field is entirely lost.

Speaking of the progress already made with incandescent burners, Mr. Holliday proceeds: "There is still much to be done to get a burner which will meet the views of consumers as a body. It appears to me that what we really require is a medium capable of resisting a greater amount of wear and tear than the mantles at present on the market,—that is to say, something approaching the hardness and durability of an ordinary flat flame or argand burner at least, and one which will develop high luminous effects with a low standard of gas. If such a burner could be placed upon the market at a very low figure and its use become universal, the amount of money which could be saved in most cases by supplying a gas of lower illuminating power would enable us to charge such a price for the gas as would render its position, even as an illuminant, almost unassailable."

Wire-Drawn Steam.

MANY years ago the relative economy of wire-drawing and expansion in the cylinder was a question much discussed, and comparative experiments were made to settle the doubtful point. The results appeared to favor so strongly the use of steam at the highest initial pressure expanded in the cylinder that throttling was relegated to second place, and expansion, either automatic or variable, was considered the correct practice.

The matter is not settled, however, to the satisfaction of all concerned, and an editorial in *The Engineer* (October 1) reopens the discussion with some points worthy of serious consideration, especially in view of modern conditions. The tests referred to, given in Murray's "Treatise on the Marine Engine," in 1858, were made with only eight pounds, pressure in the boiler, and the meager data concerning

many important details leave us in doubt as to the actual reliability of the results.

The general consideration given in recent years to the large losses due to cylinder condensation has led to a decided leaning toward superheating, and Rankine long ago showed the effectiveness of wire-drawing as a means of superheating, as well as of definitely controlling the degree of superheat thus obtainable.

Now, with the modern water-tube boilers a decidedly higher pressure can be safely maintained than is really required in the cylinder, and it is not impossible that better results would be obtained by maintaining a pressure, say, of 250 pounds in the boiler, and throttling this to 180 or 160 pounds for use expansively in the engine. The steam thus delivered to the engine would have the excess temperature due to the pressure at the boiler, and the expansion could be carried on in the cylinder as far as would have been thought advisable with an initial pressure of 160 to 180 pounds, besides having the excess temperature to counteract cylinder condensation.

A direct advantage is also gained by the greater ease with which wire-drawing permits a steady pressure to be maintained in the boilers, the higher boiler pressure practically corresponding to proportionally-increased steam-room; and the fluctuations in the demand for steam by the engine are much less perceptible at the boiler. Priming is thus reduced, and a general advantage in the steam-generating end of the plant is obtained.

The best method of wire-drawing is assumed to be that of placing the reducing valve within the steam space of the boiler, so that any heat produced by the conversion of energy may be reabsorbed in the surrounding steam; some form of nozzle, like that of an injector, is suggested as likely to give the best results.

"It seems that with water-tube boilers, the higher the pressure the better they work, and, this being so, all the advantage that can be had from wire-drawing ought to be taken. We have no hesitation in saying that in practice, with modern high pressures, more can be gained by judicious wire-drawing than by pushing expansion to a limit which is anything but judicious."

Technical Education and Foreign Competition.

ONE of the results of the pressure which foreign competition has produced in England is an awakening to a realization of the methods of work in competing countries; this includes not only the immediate mechanical methods of production, but also the influence which a higher technical education exerts upon the progress of industrial development. It is no doubt true that the division between the educated technologist and the operative workman is more sharply defined in England than in some of her competing neighbors.

This fact is fully appreciated in England, as many articles in the technical press of Great Britain show, and it was made the subject of the address of Sir William Bailey at the presentation of prizes at the Hindley Technical Schools, printed in *The Engineer* (October 22).

Sir William does not mince matters, but starts out boldly by showing the futility of self-deception in so important a matter. "Those who know anything of the work done in other countries--those who have studied the progress and skill in the first principles of the arts of industry and in the scientific use of force by our competitors abroad—know very much that should discount our pride and make us feel anxious about our commercial future prosperity. Until recently, technical education has been much ignored, if not entirely neglected, in this country. If, since the days of Elizabeth, half as much of the goodness and public piety and thought and work that has been given to the care of the poor and in the distribution of parish doles had been devoted to the prevention of ignorance, these monuments of woe and past neglect which are often the largest buildings in our towns, the workhouses, would have long since ceased to exist."

Proceeding, Sir William shows that systematic scientific investigation must take the place of mere hap-hazard inventing, so-called, and the methods of the scien-

tific inventor, trained in full knowledge of what has been done in the past, as well as the laws which govern what may be done in future, must be applied in daily work, if industrial pre-eminence is to be maintained. The manufacturing industries of England owe their existence almost entirely to the inventive skill and natural ability of a body of practical men whose work extends barely one hundred years back; and it is an interesting fact that before the year 1733, when Kay invented the fly-shuttle, the methods of spinning and weaving in England were not superior to those used by the natives of the Pacific islands or the savages of Central Africa. Further advances now, however, must be made, not by men possessing merely practical experience and great imagination.

"The inventors of the present day must be scholars and educated men. Sir Henry Bessemer is a scholar, Sir Lowthian Bell is a scholar, and the late Dr. Joule was a scholar and high-class mathematician; and the trained scholars on the continent who have the management of the iron and steel industries seriously affect the management of similar works in this country; and, unless we are more on the alert, some of our industries will be annihilated. Our mechanical appliances and improved processes, invented by Englishmen in the middle of the last century, caused us to be superior to our trade rivals abroad, and we must not be astonished when we are told that in America, and in Germany, and in France, many improved methods are being discovered which in some cases are superior to ours. The factory system that has been so successful in textile manufactures is being introduced into the production of machinery, and the hand-lathe and the common drilling-machine will shortly be ancient tools only fit for the machinery smith. It is for our manufacturers and captains of industry carefully to study the new movement, in order that we may retain and strengthen those manufactures which are being assailed."

This address is but one of many similar appeals, written and spoken, which are being made in England to endeavor to counteract the growing forces of foreign competition. Whether the awakening has come soon enough, time alone can tell; but of the reality of the danger there is little doubt, and the efforts to combat it will surely be made with energy and ability.

Railroad Building in South Africa.

DURING the past year railroad construction has been actively pushed in South Africa, and from an account in *Engineering* (October 22) some idea of the character and extent of the recent work may be gathered.

"A year ago Buluwayo was 587 miles distant by road from Mafeking, the most northern terminus then on the Cape railways; at the close of the present year the locomotive will enter that place which three years ago was but a kraal of the Matabele." This means that an average of 1¼ miles of railway have been constructed for every working day, and that this has been accomplished through a new country, with water and wood both scarce, and all supplies necessarily furnished from the rear. One can better realize what this piece of railroading means by taking the map of South Africa and tracing the course of the road as already built to Mafeking, and then carrying it on in nearly a straight line to Buluwayo.

The road will undoubtedly be an important factor in the future development of Rhodesia, and the strengthening of the British power in South Africa. The cost of traffic from Mafeking to Buluwayo by wagon was more than £100 per ton, and this will be reduced to £5 by rail. Especially is the road expected to prove of value for transportation of grain and breadstuffs, enabling men at the mines to be fed cheaply, and enormously facilitating the development of the country in every way.

The road to Buluwayo forms a portion of the system of Cape railways, and is intended to serve Matabeleland, the country to the north-east. Another branch is to be constructed, and is already partially under way, connecting Buluwayo to the port of Beira on the east coast of Africa

a little below the mouth of the Zambesi. Beira is considered one of the best ports of South Africa, the tide having a mean rise of seventeen feet, the highest on the whole coast. A narrow-gage line is already being completed from Beira to the frontier of Mashonaland, and at Umtali, the frontier town, a new line is to be constructed to Fort Salisbury.

This work involves no extraordinary engineering difficulties other than those due to the tropical climate, the dense jungle, and the scarcity, in some places, of water. On the Buluwayo line steel sleepers are necessary, as wooden crossties are quickly destroyed by the white ants. The rails are sixty pounds in weight, and the bridges over the numerous rivers are of the Cape Standard type of girders, one hundred feet being the longest span.

The rapid completion of these roads in the very heart of South Africa must accelerate the development of Rhodesia to a marked degree, and the manner in which the Transvaal is thus being hemmed in by British power is worthy of consideration. Although the railways are undoubtedly built for commercial purposes in the first place, yet the strategic importance can hardly be considered as secondary. With double railway communication with excellent ports both on the south and the east coasts, forces and supplies could be thrown against the Transvaal from the front and the rear, while the absence of any sea communication, except through Portuguese territory, prevents any corresponding railroad connections from being built by the Boer government. The growth of British influence and power has everywhere been marked by railway construction, and South Africa is no exception to this rule. The development may be expected to proceed at an accelerating rate, and the outcome must soon be reduced to a question of endurance.

Electricity on the London Underground.

FOR some time the question of the substitution of electricity for steam as motive power on the London Underground Railways has been discussed, and in an editorial in *The Electrical Review* (October 15) some account of the present status of affairs is given.

The smoke and gas which render the underground travel so disagreeable can only partially be removed by fans and ventilating devices, and even these remedies have not been generally applied; and it is evident that the proper method of relief lies in a change of motive power. This is officially affirmed in the report of a special board of commissioners, in which it is most emphatically stated that the use of electric traction upon these roads will alone give a radically permanent improvement.

There are financial reasons which must be met before such a change can be undertaken, but, apart from these, the writer of the editorial assumes that there are "some very heavy technical difficulties to surmount before an efficient electric service can be set going." He then adds, however, that "engineers are in a much better position for giving satisfaction at the present time than they were a year or two since."

The technical difficulties referred to appear to be almost entirely included in the application of electricity to the present system of train service, and the system of signalling now in use would hardly permit any material increase in carrying capacity, if electric motors were merely substituted for steam locomotives. Then there are a number of trains belonging to the Great Western and North Western railways which are run on some parts of the Inner Circle, and it is hardly practicable to run the steam and the electric trains on the same roadway to advantage. In fact, there would be little use in putting in electric service at all on this portion of the underground, if steam locomotives also were permitted, since the smoke and gases from a few engines would be sufficient to foul the air.

The true remedy lies in the entire use of electricity, and in the complete abandonment of the locomotive-drawn train, substituting the independent motor cars which form one of the chief advantages of the electric system. An almost continuous flow of cars could then be kept up, and

London receive something she has not known since the underground was started, —*i. e.*, ample transportation facilities combined with absolute freedom from smoke and gas.

The *Electrical Review* adds: "In conclusion, it may be said that several years of steady working have shown the absolute success of electric traction upon the Liverpool overhead railway—a line where the service resembles in almost every particular that of the Inner Circle, except that the latter is, of course, considerably heavier, and has some amount of through traffic from other lines outside. We cannot think that the mere incident of one line being essentially in tunnel and the other in the open should make it impossible to operate the former successfully by the same methods that have done so well on the latter."

The Colombo Harbor Works.

THE port of Colombo, in Ceylon, is one which has constantly advanced with the growing trade of Southern India, and the expansion of Australia and New Zealand, and, from being an open roadstead, swept by the monsoons, it has been gradually improved, until, when the present and contemplated works are completed, it will be one of the finest harbors in the world.

An account of the improvements at Colombo, with hydrographic chart and plan, is given in *Indian Engineering* (September 4), containing many points of engineering interest.

The great monsoons which damage the shipping at Colombo come from the southwest; hence the first attempt to improve the harbor was the construction of a protecting breakwater on this quarter. This breakwater, which was one of the first to be constructed of concrete blocks made from Portland cement, is composed of a mound of rubble, brought up to twenty-four feet under low water, surmounted by concrete blocks weighing thirty-five tons each, set on edge, the plans being those of the late Sir John Coode, well known to engineers in all parts of the world for his experience in harbor works. The work constructed in 1875, has served its purpose well, withstanding the heavy storms and protecting the harbor from one side.

The new works, commenced in 1894, provide protection from the north and northwest, enclosing the entire space available for harbor construction, giving more than 600 acres of shelter area,—that is, exceeding the first-class Imperial Harbor of Refuge at Dover. These works, the cost of which is estimated at $4,550,000 are to be completed in eight years from, the date of the commencement, and are already completed to an extent which adds much to the harbor protection.

The enclosure of the harbor also renders possible the construction of a graving dock, which has been greatly needed.

At the present time all vessels are obliged to go from Ceylon to Bombay not only for the repair of serious injury, but also for the scraping and cleaning of the hulls, so frequently necessary in the Indian ocean. The coaling station is also to be greatly enlarged, thus making Colombo an important naval station.

The above estimate does not include the graving dock, this being a separate item of about $1,500,000, one-half of which is to be borne by the home authorities.

In connection with the account of these harbor improvements, it is interesting to note that the mercantile shipping frequenting the harbor of Colombo has increased from 700,000 tons in 1881 to 2,800,000 tons at the present time, besides the increase in naval requirements; so that the wisdom of expending the abovementioned sums is fully established.

The Ventilation of Mines.

THE question of the proper ventilation of mines, and especially of collieries, has always been one of the important problems of mining engineering. Originally performed by the draft produced by furnace heat, this method has gradually been superseded by fan ventilation, until it has been for some time supposed that the use of fans, at least in large collieries, was the only proper method.

In a recent issue of the *Colliery Guardian* (October 8) Mr. H. W. Halbaum revives the idea of furnace draft for mine ventila-

tion, and advances some strong points in its favor, quoting especially the work of a ventilating furnace at a large modern colliery in the north of England, and claims that, in some instances, it may be a decidedly better policy to ventilate a mine by means of a furnace than to ventilate it by means of a fan, even where a large volume of air is required.

This is true only in some instances, and it is to investigate those instances that the paper referred to was prepared. The real fact is that there are usually auxiliary aids to mine ventilation, which may be made of greater or less assistance, according to the method adopted for producing the main current of air. Where there are underground boilers and engines, the heat emitted may be so directed as to assist the upward current, and this may be made a useful auxiliary. In some cases, as Mr. Halbaum shows by a fully-computed example, an apparent furnace efficiency of more than 200 per cent. was demonstrated, based on the fuel consumed and the volume of air discharged. The impossibility of the truth of this, notwithstanding the correctness of the computation, led to the discovery that the mine air, which passed through the grate and fire-bed, contained enough combustible gases to add very materially to the quantity of heat generated, and to this and other sources of heat in the mine the excess work was due.

The fact that the mine air was combustible did not necessarily imply that there was danger of explosion, since it is quite possible for such proportion of gas to be present as to be capable of burning when in contact with incandescent fuel, and yet be entirely incapable of explosion, or even combustion, when taken apart from the furnace fire. Neither combustion or explosion can be propagated through the mass of so weak a mixture. This is well known in the case of a very "poor" producer gas; it will ignite and furnish a hot flame when a torch is held in its current, but the flame will instantly go out when the torch is removed, and the gas cannot be made to explode.

Mr. Halbaum also showed that, even when the assistance of this auxiliary fuel is not available, there are conditions under which the furnace, considered as a machine for moving air by the combustion of fuel, may be nearly, if not quite, as efficient as the more complicated mechanism of boiler, engine, and fan. Summing up, he concludes:

"First, there may be circumstances in which a furnace, viewed from the commercial-standpoint as a mine ventilator, may be more than able to hold its own with any type of ventilating fan.

"Second, a mine current containing an imperceptible percentage of fire-damp, or other combustible gases, is charged with an immense store of potential energy, which, under certain conditions, may be harnessed in the service of man."

THE CONTINENTAL PRESS

The Improvements at the Mouth of the Loire.

THE harbor of St. Nazaire, at the mouth of the Loire, has been an important seaport for many years. The regular mail steamship lines for the Antilles and for Mexico make it their port, much miscellaneous commerce uses the harbor, and many vessels pass up the river to the city of Nantes. Of late years there has been a perceptible shallowing of the channel, which formerly sounded a depth of twenty-two feet over the bar, and it has been found necessary to carry out extensive improvements in order to maintain freedom of access to the harbor. The works are fully described in the official record of the engineer, M. de Joly, in the *Annales des Ponts et Chaussées* (Part I, 1897), and the account is a valuable contribution to hydrographic work and harbor improvement.

The channel at the mouth of the Loire, although there was a well-defined bar, did not appear to shift or become shallower until comparatively recent years; but in 1871, much to the surprise of the residents, the steamer Florida, drawing twenty-two feet, found it very difficult to get over the bar, and the frequent recurrence of such detentions revealed the fact that the channel was filling up.

Hydrographic surveys showed that not only was the bar increasing, but that it had also shifted its location. By 1881, the depth of water in the channel had diminished to about twelve feet, and it was evident that, unless something was soon done, the port of St. Nazaire would be doomed.

The report of a government commission appointed to investigate the matter, recommended dredging, but this was opposed by M. Bouquet de la Grye, on the ground that the bar was composed of fine sand, which, under the influence of the currents and the prevailing winds would fill up the new channel almost immediately, rendering the work useless. The discussion led to a thorough investigation of the causes of the formation of the bar, with a view of so directing the improvement works as to render the results as permanent as possible.

The result of these investigations, including a combination of the influences of tides, currents, and prevailing winds, pointed to the conclusion that the best location for a permanent channel would be at another point in the bar than that hitherto used, and that the Saint-Marc channel, formerly the main channel, should be replaced by a deepening of the *traverse des Charpentiers*—so-called from certain rocks in the harbor.

After some experimental work this plan was adopted, and four powerful suction-dredges were set to work removing the sand from the line of the new channel, the contract providing for the removal of 1,000,000 cubic meters of sand (about 1,308,000 cubic yards) at a price of 80 centimes per cubic meter (12¼ cents per cubic yard), in twenty-six months.

As a matter of fact, the million cubic meters were removed in fourteen months, and a channel having a minimum depth of 6 meters (nearly 20 feet) and a width of 100 meters has been made through the Charpentier bar. One suction-dredge is maintained in service to guard against initial filling of the new channel, but there is every evidence that the care which was given to the selection of the location will make the maintenance of the channel an easy task.

The change in the position of the harbor entrance involved a rearrangement of the harbor lights and the construction of two new lighthouses, and, with the completion of this important detail, not only the port of St. Nazaire, but also the valuable river traffic of the city of Nantes, will be preserved and developed.

The Stockholm Exposition.

INTERNATIONAL expositions, as a rule, have a sameness about them which renders it difficult to select really salient points for description, but the recent exposition at Stockholm was distinctive enough to be worthy of special notice. Various accounts have appeared in the continental press, among which, for a general review, we may refer to that in *La Revue Technique* (September 25).

The original idea of the exposition, which was projected in 1894, was to furnish a demonstration of the recent progress of the Scandinavian peninsula only, but the inclusion of Russia practically resulted in the production of an exhibition of the arts and industries of the entire north of Europe, Denmark included.

Instead of borrowing the designs of other countries and periods, the architects, Messrs. Boberg and Lilljeqvist, produced buildings distinctively Scandinavian and local in design and coloring, with the result of impressing upon spectators the northern character of the exposition and its Scandinavian and Slavonian nature.

Norway and Sweden naturally made valuable exhibits in metallurgical products, especially in iron and steel, the forges of Motala and Bergsund being well represented, both in exhibits and in constructive details of the buildings. The fine carpentry and woodwork of Sweden was in ample evidence, and the great Palace of Industry, the main building of the exposition, is claimed to have been the largest wooden building ever made, covering an area of more than 160,000 square feet, and rising to a height of 310 feet at the top of the cupola.

The electrical exhibit was especially notable from the fact that the dynamos, of 200 h. p. each, were driven by de Laval steam turbines, actuated by steam at one thousand atmospheres' pressure, generated in special boilers, also designed by M. de Laval.

Historical and ethnological exhibits found place, an entire history of Swedish mining being made in the mining pavilion, while a great ethnographic museum, under the skilful direction of M. Hildebrand, the royal antiquary, was arranged in the open park within the grounds, including reproductions of portions of old Stockholm, and other historical subjects, furnishing both instruction and entertainment.

It is a question whether local expositions of this nature are not of more real value than the great aggregations of commercialism from all parts of the world known as "international expositions"; and it is more than probable that the great shows of the coming century will be thus differentiated either by subject or locality, to the real benefit both of exhibitors and visitors.

Chinese Mining Communities.

THE advancement of the works of the Trans-Siberian Railway into the Chinese gold fields of Manchuria is bringing to light much curious information about the Chinese methods of gold-mining, as well as the peculiar social institutions of the mines, and their relations to the empire. From an interesting article by M. de Batz in *Le Génie Civil* (September 25) we make some extracts.

The Chinese miners live in independent communities, having their own local government, under rulers of their own choosing. The most characteristic of these communities is that at the placers of *Tsia-pi-goou*, which has been in existence for a long time; thirty years ago, when this locality was visited by the archimandrite Palladius, the organization numbered ten thousand miners. The community is under the authority of a single leader, called the *da-è*, with whom two subordinate governors are associated. The gold obtained belongs to the entire community, being divided by the leader, with reservation of a portion for the needs of the non-productive workers and for the care of the sick. The *da-è* possesses arbitrary power for the judgment of disputes, and the administration of justice, even to the infliction of the death penalty; and the entire community is under his absolute rule. The Chinese government appears to have abandoned any attempt to exert authority over the miners, and, instead, has tacitly

acknowledged the community by accepting from it a sort of resident representative with the governor of the province, through whom dealings are made with the imperial authorities.

Any attempt at independent mining in this district under such conditions is not to be considered, but it does not appear that new-comers are repulsed, if they are willing to do their share of the work and accept the community system of sharing the product.

Another powerful organization, which flourished until recently, was that known as the free community of miners of the Jeltouga. This body was first discovered in 1860, existing in a secluded valley in the Khingan mountains, where the placers were worked secretly, many of the miners being Russian exiles who had escaped from Siberia. The discovery of very rich gold deposits in this portion of the Amoor Valley in 1883 brought the district into notice, and many gold-seekers flocked thither, so that by 1885 the population of the valley reached nearly 15,000.

The influx of turbulent characters tried the stability of the primitive organization severely, but the formation of a sort of vigilance committee kept the disorderly elements under control until a strong arbitrary government was formed by a majority of the population, upon a community basis. The miners were divided into parties called *artels*, composed of nine men each, working on assigned and limited territory, and turning their output into the common fund. No miner was admitted into an *artel* without the consent of the others, and any one unable to work was obliged to furnish a substitute. The gold-bearing gravel was excavated from pits and washed in a primitive manner, and the richness of the deposits may be inferred from the fact that the average result of the washings of each *artel* of nine men, in a party of eight hundred working on a placer along the Arakane, was a little more than one kilogram of gold per day (a value of about $660).

Trouble, however, arose between the Russian and Chinese authorities in regard to the community, the Russian government forbidding its subjects to cross the Amoor into Chinese territory, the camp having become a refuge for escaped Siberian exiles. For a time the armed strength of the community was too great for the Chinese government, but, after several attempts, the independent government of the miners was broken up, and the rich placers are now worked by a Chinese stock company operating under a government concession, and organized by Li-Hung-Chang.

There seems to be little doubt that the Siberian railway will be the means of opening up valuable gold fields hitherto unworked, or worked only in a very imperfect manner, and that the immediate effect will be the suppression of much of the free mining, and of many of the mining communities.

Old Paper.

FROM time to time we hear various prognostications as to the ephemeral character of all modern printed and written works, owing to the bad quality of modern paper, and computations have been given of the extreme limit of duration of books and documents.

Fading inks on decaying paper are supposed to doom all modern literature to a short life, and the strong and durable paper of the "good old times" is held up as a reproof to the makers of the modern flimsy article.

A very interesting article in the second part of the *Mitt. aus den Kg. technischen Versuchsanstalten*, or transactions of the government testing laboratory, by Herr W. Herzberg, goes to show that, like many other stories of the good old times, the paper of past days was often not so good as that now made, and that, indeed, most of it was pretty poor stuff.

The author of the article goes into the history of paper-making in Europe, from the time of its introduction into Spain by the Moors in the eleventh century down to comparatively recent times, and shows that from its earliest use paper was thought fit only for passing documents, and that, when it was first used in bound books, it was thought necessary to bind

alternate leaves of parchment and paper, as the latter was considered too brittle to stand the strain. Public documents were forbidden to be engrossed on so fragile a material as the earlier paper was found to be, and it was only as the art advanced that the new material superseded parchment.

A careful inspection of several hundred old codices in the Royal Library at Berlin fails to reveal any lasting properties of the old paper upon which they were written. On the contrary, the leaves are in very many instances crumbling into brittle fragments, while the writing has become illegible.

The durability of paper has been supposed by many to depend upon the material of which it is made, and the adoption of other substances than rags has been the origin of the alarm as to the poor quality of modern paper. As a matter of fact, the method of manufacture has so much to do with the strength and quality that the material is only one of several elements to be taken into consideration. Doubtless there is much poor paper made to-day, but there is also better paper made than any which existed in the "good old times," while almost any book now printed may be expected to show greater powers of endurance than those made on the best paper of preceding centuries.

Paris Sewer Construction.

In the course of the improvements in the sewerage of Paris, it was decided, in 1894, to construct a new main collecting sewer from the place de la Trinité to the siphon which passes under the Seine at Clichy. The large size of the proposed sewer, known as the *Collecteur de Clichy*, and the fact that the route passed under important and much-travelled streets, filled with shade trees and carrying tramways, caused the authorities to hesitate about cutting a trench for the conduct of the work. It was therefore decided to adopt a system of tunnelling, with such arrangement of shields and supports as would maintain the surface of the roadway intact, and permit the entire work to be carried on below ground, although the top of the sewer arch at places would come within three feet of the surface.

An account of the method and apparatus employed is given in the *Annales des Ponts et Chaussées* (Part I, 1897), showing very clearly how this important and difficult work was accomplished, and demonstrating how possible it is to avoid the upheaval of city streets for such constructions.

The sewer is of oval section, 20 feet wide and 16½ feet high inside, with arched walls averaging 21 inches thick, there being a central channel along the bottom, 13 feet wide by 6½ feet deep, for the flow of sewage, with narrow footways on each side, much the same as in the other main sewers of Paris. The total length of sewer is 3,970 yards, which was divided into two contracts, the first, including that portion without the fortifications, 1,610 yards long, and near the surface of the soil, and the second, 2,360 yards long, within the city limits.

In order to support the soil and the load upon the superincumbent roadway, it was necessary to adopt a metallic shield similar to that devised by Brunel for the construction of the Thames tunnel, and this shield was followed by a system of moveable centers, or frames, upon which the masonry was constructed and supported. As there was no liquid mass to be encountered, the end of the shield was left open, the structure really forming an elliptical ring of plate-iron with sharp edges, reinforced with angles and braces, and carrying six hydraulic cylinders, by means of which it could be forced forwards. The rams of these cylinders thrust back against the masonry ring previously constructed, through the medium of the metallic centerings already mentioned, while a horizontal bucket-conveyor kept the space just back of the shield free from earth as rapidly as the excavation progressed.

The general conduct of the work was simple, and will readily be understood with a knowledge of this apparatus. The hydraulic jacks had a stroke of one meter, and, as the earth was excavated in front, the shield was steadily forced forward, until the limit of stroke had been reached.

The pistons were then drawn in, and a metal center erected behind them, and the work of filling in the masonry followed closely behind the shield. A length of about fifty feet behind the shield was kept supported and braced by metallic centers, beyond which the masonry had become sufficiently solid to need no further support. A light platform, carried along the middle of the tunnel, supported a small track by which the masons were supplied with material, while the excavated earth or other similar material was hauled away below. Thus the work went on continuously.

The interior of the tunnel was kept well lighted by electricity, and all motive power for ventilating, hauling, pumping, etc., was supplied by electricity. The details were slightly different in the two portions of the work, owing to the different depths at which the tunneling was conducted, but the general construction was practically the same.

By the use of this apparatus, a sewer of 20 feet by 16 feet was thus successfully built for a distance of more than two miles under one of the busiest portions of Paris, the work progressing continuously at the rate of about six lineal yards in twenty-four hours, without causing the slightest obstruction to travel and without deranging the surface-paving. The contract price was about $200 per lineal yard, including the construction of all the apparatus.

Recent German Bridges.

WE have noticed at various times in these columns some of the important new bridges planned and under construction in various portions of Germany, and there is little doubt that this activity in bridge-building has contributed not a little to the present stimulus in the German iron and steel industries.

The principal bridges now being constructed in Germany are illustrated and compared in an article by Prof. Foerster, of the Dresden Technical High-School, published in *Stahl und Eisen* (September 15), from which we can gather some interesting facts.

The most noteworthy feature about these modern bridges is the practically universal use of the long span braced arch. Where a viaduct is to be carried over a deep valley, as at Müngsten, sufficient rise is afforded for an overhead bridge without difficulty, and a wide span arch is readily designed without overstepping economical proportions. Excellent precedents exist for this form of construction in the examples of the Garabit viaduct in the Pyrenees, and in the Luiz I. viaduct over the Douro at Oporto; and the Müngsten viaduct nearly approaches the latter in dimensions, being 492 feet clear span, with a total length of 1,525 feet, and a height above the river Wupper of 350 feet.

Like the Garabit viaduct, the great arch at Müngsten has been constructed without supporting false-works, the two halves of the span being carried out to meet each other, cantilever fashion.

Of the four new bridges now being built over the Rhine, two—those at Bonn and Düsseldorf—are designed with long-span arches, and, as these are low-level bridges, the necessary rise is obtained by carrying the arches far above the roadway and suspending the latter from them.

At Bonn two smaller arches of about 350 feet span extend from the banks to the piers from which the main arch of 640 feet springs, the roadway passing above the side arches and between the high braced arches of the main span.

The bridge at Düsseldorf has already been discussed at length in a previous review, and its two great arches of 594 feet span are practically identical in design and proportion with that of the bridge at Bonn.

Two bridges are under construction at Worms, one for general road traffic and the other a railroad bridge, each consisting of three arches of nearly equal span. The road bridge is of deck construction, the roadway passing entirely above the arches, and the lighter service permitting the flatter and shallower arches without unduly increasing the stresses, while the railroad bridge resembles in general design those at Bonn and at Düsseldorf,

with the modifications in proportion due to the reduced span—about 330 feet.

The cost of these four Rhine bridges and the Müngsten viaduct is estimated at more than $4,000,000,—a very respectable sum to be expended in a limited time in one line of work,—and the completion of these notable structures will materially advance Germany as a possessor of fine bridges.

Portable Bulkheads for Mines.

ONE of the greatest obstacles encountered in combating fire-damp, or smoke, or noxious gases in mines lies in the difficulty of constructing bulkheads in the gangways leading to the dangerous portion of the mine and excluding the gases from the remainder of the workings while relief work is going on. A timber bulk-head, to be gas-tight, must be carefully constructed, and cannot be rapidly made, and workmen have frequently been overcome or driven back by the gas or smoke which they were endeavoring to exclude. In such work, time is the important element, and a few minutes may make all the difference between success or failure in so vital a piece of emergency service as the closing of a passage-way through which suffocating gases are pouring.

A recent scheme for meeting this difficulty has been devised by Herr Wagner, the superintendent of Prince Hohenlohe's mines at Michalowitz, in Silesia, and is fully illustrated and described in *Glaser's Annalen* (October 1). The device consists of a so-called portable " dam " similar in construction to an air mattress, which, when inflated with air, swells to an extent sufficient to close so tightly the gangway in which it is placed that no gas or smoke can pass.

The dam is composed of strong cotton fabric vulcanized with Para rubber and further rendered air-tight by a second layer of balloon-fabric. The front and back surfaces of the dam are connected at intervals within by straps about twelve inches long, so that, when fully inflated, the whole assumes the form of an elastic air mattress about twelve feet square by one foot thick, and, if placed on edge in a gangway of slightly smaller dimensions, the dam will effectually close the entire area. One side of the dam is provided with a suitable valve, gage, and hose connection; and a small portable hand-pump enables the inflation to be rapidly accomplished.

The whole apparatus, when deflated, is very portable, and can be carried like a stretcher upon the light rods which are used to support it during inflation. Inflatable air bags have frequently been used to close off sections of large gas mains at points where no valves were available, and the use of such a device in a channel of regular outline readily suggests itself; but we believe Herr Wagner is the first to extend the use of such obstructions to large and irregular passages, such as mine gangways and his apparatus has been found successful in practice in Germany in cases of gas and coal-dust explosions.

The Eckmühl Lighthouse.

THE already famous lighthouse system of France has recently been enriched by the completion of the fine " Eckmühl " lighthouse situated on the point of Penmarc'h on the Breton coast, in the department of Finistèrre. Full details are given in *Le Génie Civil* (October 9). This lighthouse owes its existence to the bequest of 300,000 francs, left for the purpose by the will of the late marquise de Blocqueville, the daughter of Marshal Davoust, prince of Eckmühl, historically famous as one of the ablest generals in the service of the great Napoleon. As the name indicates, it is intended not only to warn mariners from the dangerous coast of Brittany, but also to serve as a monument to the memory of the marshal of the empire, whose line has now become extinct.

The structure is a fine octagonal tower of granite, 207 feet high, with additional buildings for the reception of machinery and for the residence of the attendants. This height is sufficient to enable the tower to be seen for a distance of more than twelve miles on a clear day, while at night the powerful light penetrates more than sixty miles in clear weather, and, even in the misty atmosphere so fre-

quently encountered on this coast, it can be seen for twenty-five miles.

The light used in the new tower is an improved form of flashing electric light, similar to that which has already been used in the Hève lighthouse, but much more powerful, photometric measurements placing its intensity at 30,000,000 candle power. The particular method of flashing called the "lightning-flash" has been devised by M. Bourdelles, the director of the French lighthouse service, and consists of a continuous series of flashes following each other as closely as practicable without longer duration than is necessary to permit a perception of the separate intervals. This has been found to be accomplished best by making the duration of the flashes about one-tenth of a second, the result being an effect similar to that of lightning. In investigating this system, care has been taken to determine the duration necessary for the flash to impress its maximum brilliancy upon the human eye, as any shorter period would result in an apparent diminution in the power of the light. Careful laboratory experiments by M. Charpentier have shown that the full intensity of a white light is appreciated by the eye between one-eighth and one-twelfth of a second, and hence for the French lighthouse service one-tenth of a second has been chosen.

The lighting apparatus is double throughout, two Serrin lamps with Fresnel lenses and prisms being arranged so as to be used either singly or together; the whole system is supported on a vertical shaft, the weight being balanced by a hollow iron float in a vessel of mercury, thus relieving the pivot from the pressure, and limiting the function of the vertical shaft to that of guiding and centering the moving parts.

Two independent steam engines of twelve horse-power each operate the alternating electric generators of the Labour type, and an air-compressor furnishes a blast for the operation of a powerful siren for use during fog. In order that the siren may be ready for immediate service in case of sudden fogs, a supply of air compressed to thirty pounds per square inch is maintained in a reservoir.

The completion of the Eckmühl lighthouse brings the number of electrically-illuminated lighthouses on the French coast to thirteen, this being many more than are in use by any other nation; indeed, it is generally admitted that no coast is so well provided with powerful and effective lights as that of France.

The Caissons of the Alexander III Bridge.

THE work upon the new bridge across the Seine at Paris, which is to form so conspicuous a feature of the coming exposition is being pushed steadily forward, and in *Le Génie Civil* (September 11) is given a fully illustrated account of the immense caissons upon which the piers will rest. The horizontal thrust of the arch will be very great, because of the extreme flatness of the curve, and this, together with the extreme width of the bridge (130 feet), causes the dimensions of the piers to be unusually great. The caissons measure 145 by 109 feet, by 12 feet deep, being second only in size to those for the towers of the Brooklyn suspension bridge, although the latter is more than five times the span of the Paris bridge.

The foundations within the caissons will be of Portland cement concrete, the caissons being sunk by means of the compressed-air system, each caisson being divided into five compartments having separate air shafts.

The walls are made of iron six millimeters thick, very thoroughly braced within, the lower edges, both of the outside sheets and of the inner partitions being shaped so as to penetrate the soil readily, as the structure sinks. A horizontal division extends over the whole area of each caisson, a little more than six feet from the bottom, and it is only below this portion that the pneumatic work is conducted, the masonry of the pier being built above.

Apart from the size of the foundations and the importance of the structure, there is no especial feature of note in this work. The location is comparatively free from

diffculties, a sufficiently hard bottom being readily found at twenty-five to thirty feet below the surface of the Seine; and the experience which has so recently been acquired in the construction of the Pont Mirabeau furnishes excellent precedent for the present work, especially as the same contractors have it in charge.

Owing to the great area of these foundations, the pressure per unit of area has been kept within reasonable limits. Including dead weight and the vertical component of the arch thrust it is computed to be less than 2 kilograms per square centimeter (28.44 pounds per square inch).

The excellent progress which has been made upon the foundation work on both sides of the river gives assurance that the bridge will be completed within the required time, and that this important and conspicuous feature of the exposition will be entirely ready before the opening day.

Mechanical Recording Apparatus.

THE experiments of Professor Marey in animal locomotion, and the ingenious forms of apparatus which he devised for the purpose of investigating and recording animal movements, made his name well known in that connection many years before the application of instantaneous photography by Muybridge and his successors. An interesting article upon the general subject of mechanical recording devices by Professor Marey, in *La Génie Moderne* (September 15), possesses, therefore, especial value from the long and varied experience of the author in this line of investigation.

Many of the recent improvements in such apparatus are the direct results of the general advances in the art of photography. The production of exceedingly rapid emulsions, and the use of long celluloid films as supports, have alone rendered possible such devices as the kinetoscope and cinematograph,—instruments which, apart from their popular use as apparatus for entertainment, give unparalleled opportunity for the study of animal motion. Any special movement may be projected upon the screen in such a manner as to enable every phase to be examined in detail, at so moderate a rate of speed as to avoid any uncertainty or confusion. Compound movements may be investigated and dissected, and the entire subject revealed in a manner not otherwise possible.

In like manner the phonograph has been applied to special investigations of sound, including the study of "timbre," or the analysis of the various vibrations present in any sound of mixed character. This has been accomplished by Hermann, of Königsberg, by means of an ingenious auxiliary apparatus, which converts the indentations upon the cylinder of the phonograph into their corresponding curves, and these, by a subsequent harmonic analysis, may be separated into their various simple elements.

A still more recent application of chrono-photography is the attempt of MM. Roux and Balthazard to apply the Röntgen rays to continuous photography; and already some measure of success has been gained in photographing the internal organs in successive phases of motion, and thus investigating the mechanics of their action. The continued application of mechanical recording apparatus to the study of kinematic problems, whether in animate or inanimate subjects, cannot fail to add much to our knowledge in many directions, since we not only fix a permanent record of passing phenomena, but also eliminate one of the most confusing elements in all such work—the personal errors of individual observers. The work of many investigators may thus be preserved and compared, and an average result obtained, which will be nearer the truth than the work of any individual could be.

THE ENGINEERING INDEX

INTRODUCTORY

This Index is issued separately from the Magazine printed on one side of the paper only, and is supplied to subscribers to THE ENGINEERING MAGAZINE at a nominal charge of fifty cents a year to cover cost. In this form it meets the exact requirements of those who desire to clip the items for card-index purposes.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed, and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 15c. The letter A, B, or C denotes a price of 30 cts.; D, of 45 cts.; E, of 60 cts.; F, of 75 cts.; G, of 90 cts.; and H, of $1.25. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

The titles and addresses of the journals regularly reviewed are given in full below, but only abbreviated titles are used in the Index. Other abbreviations employed are: Ill=Illustrated; W=Words; Anon=Anonymous.

To avoid the inconvenience of small remittances, and to cheapen the cost of articles to those who order frequently, we sell the coupons which are represented here in miniature.

The price of these coupons is 15c. each, or fifteen for $2, forty for $5, and one hundred for $12.

This Coupon will be received by us in payment for any 15 cent article catalogued in "The Engineering Index" of the ENGINEERING MAGAZINE. For articles of a higher price, one of these coupons will be required for each 15 cents: thus a 30 cent article will require two coupons, a 45 cent article three coupons, and so on.
The Engineering Magazine, New York:
Please send Article No. _____ to the following address:
Facsimile Not Good

With a supply of these coupons on hand no letter writing is required. Simply fill in the number, and your address. A stamped envelope does the rest.

This system is strongly commended to our readers. The coupons need only a trial to demonstrate their convenience.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

Age of Steel. *w.* St. Louis, Mo.
American Architect. *w.* Boston, Mass.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, Minn.
American Journal of Science. *m.* New Haven, Conn.
American Journal of Sociology. *b-m.* Chicago, Ill.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, Pa.
American Shipbuilder. *w.* New York.
Am. Soc. of Irrigation Engineers. *qr.* Denver, Col.
Am. Soc. of Mechanical Engineers. *m.* New York.
Annals of Am. Acad. of Pol. and Soc. Sci. *b-m.* Phila., Pa.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, Mass.
Architecture and Building. *w.* New York.
Architektonische Rundschau. *m.* Stuttgart.
Atlantic Monthly. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automotor and Horseless Vehicle Journal. *m.* London
Bankers' Magazine. *m.* New York.
Bankers' Magazine. *m.* London.
Bankers' Magazine of Australia. *m.* Melbourne.
Berg- und Hüttenmännische Zeitung. *w.* Berlin.
Board of Trade Journal. *m.* London.
Boston Journal of Commerce. *w.* Boston, Mass.
Bradstreet's. *w.* New York.
Brick Builder. *m.* Boston, Mass.
British Architect. *w.* London.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Phila., Pa.
Bulletin of the Univ. of Wisconsin, Madison, Wis.
California Architect. *m.* San Francisco, Cal.
Canadian Architect. *m.* Toronto, Ont.
Canadian Electrical News. *m.* Toronto, Ont.
Canadian Engineer. *m.* Montreal, P. Q.
Canadian Mining Review. *m.* Ottawa, Ont.
Century Magazine. *m.* New York.
Chautauquan. *m.* Meadville, Pa.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Dingler's Polytechnisches Journal. *w.* Stuttgart.
Domestic Engineering. *m.* Chicago, Ill.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineer. *w.* New York
Electrical Engineering. *m.* Chicago, Ill.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Rundschau. *b-m.* Frankfurt.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnisches Echo. *w.* Magdeburg.
Elektrotechniker. *b-m.* Vienna.
Elektrotechnischer Anzeiger. *s-w.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.

Engineer. *w.* London.
Engineer. *s-m.* New York.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering Assn. of the South. Nashville, Tenn.
Engineering and Mining Journal. *w.* New York
Engineering Magazine. *m.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of the School of Prac. Sci. Toronto, Ont.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, Pa.
Fire and Water. *w.* New York.
Forester. *bi-m.* May's Landing, N.J.
Fortnightly Review. *m.* London.
Forum. *m.* New York.
Foundry. *m.* Detroit, Mich.
Garden and Forest. *w.* New York.
Gas Engineers' Mag. *m.* Birmingham, England.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glasers Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Gunton's Magazine. *m.* New York.
Harper's Weekly. *w.* New York.
Heating and Ventilation. *m.* New York.
Ill. Carpenter and Builder. *w.* London.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *w.* Calcutta.
Indian Engineering. *w.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago, Ill.
Iron Age. *w.* New York.
Iron and Coal Trades' Review. *w.* London.
Iron & Steel Trades' Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* Wash., D. C.
Journal Assn. Eng. Societies. *m.* Phila., Pa.
Journal Franklin Institute. *m.* Phila., Pa.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q* New London, Conn.
Journal Political Economy. *q.* Chicago, Ill.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Journal of the Society of Arts. *w.* London.
Journal Western Soc. of Eng. *b-m.* Chicago, Ill.
Kansas University Quarterly. *qr.* Lawrence, Kan.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore, Md.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Master Steam Fitter. *m.* Chicago, Ill.
Mechanical World. *w.* London
McClure's Magazine. *m.* New York.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, Pa.
Mining and Sci. Press. *w.* San Francisco, Cal
Mining Industry and Review. *w.* Denver, Col.
Mining Journal. *w.* London.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Monatsschrift des Württ. Vereines für Baukunde. 10 parts yearly. Stuttgart.
Moniteur des Architectes. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Affairs. *qr.* New York.
Municipal Engineering. *m.* Indianapolis, Ind.
National Builder. *m.* Chicago, Ill.
Nature. *w.* London.
Nature. *w.* Paris.
New Science Review. *qr.* New York.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oesterr. Monatsschr. für den Oeff. Baudienst. *m.* Vienna.
Oesterr. Zeitschrift für Berg- & Hüttenwesen. *w.* Vienna.
Physical Review. *b-m.* New York.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineer's Club. *q.* Phila., Pa.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of C. E. *yr.* La Fayette, Ind.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago, Ill.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago, Ill.
Railway Review. *w.* Chicago, Ill.
Railway World. *m.* London.
Review of Reviews. *m.* New York.
Revue Technique. *b-m.* Paris.
Sanitarian. *m.* Brooklyn, N. Y.
Sanitary Plumber. *s-m.* New York.
Sanitary Record. *m.* London.
School of Mines Quarterly. New York.
Schweizerisches Bauzeitung. *w.* Zurich.
Science. *w.* Lancaster, Pa.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Scientific Machinist. *s-m.* Cleveland, Ohio,
Scribner's Magazine. *m.* New York.
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, N. Y.
Southern Architect. *m.* Atlanta, Ga.
Stahl und Eisen. *s-m.* Dusseldorf.
State's Duty. *m.* St. Louis, Mo.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* Hoboken, N. J.
Stone. *m.* Chicago, Ill.
Street Railway Journal. *m.* New York
Street Railway Review. *m.* Chicago, Ill
Technology Quarterly. Boston, Mass.
Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* New York
Transport. *w.* London.
Western Electrician. *w.* Chicago, Ill
Western Railway Club, Pro. Chicago, Ill.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Wisconsin Engineer. *qr.* Madison, Wis.
Yale Scientific Monthly. *m.* New Haven, Conn.
Zeitschrift für Lokomotivführer. *m.* Hannover.
Zeitschrift f. Maschinenbau & Schlosserei. *m.* Berlin.
Zeitschrift des Oesterr. Ing. und Arch. Ver. *w.* Vienna.
Zeitschrift des Ver. Deutscher Ingenieure. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.
Zeitschrift für Instrumentenkunde. *m.* Berlin.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

Court Buildings.

Court Buildings and Prison at Leipa, Bohemia. (Gerichtsgebäude und Gefangenhaus in Böhm-Leipa.) General description, with elevation and plans of these important civil buildings. 5000 w. 5 plates. Oesterr Monatschr f d Oeffent Baudienst—Oct., 1897. No. 16-194 D.

Edinburgh.

A Building Problem in Edinburgh. Extracts from report of Mr. M'Crae. The completion of the North Bridge makes it necessary to decide what shall be done with the sites for building along the new approach. The writer advocates the completion of the improvement, by the Council. 2700 w. Arch, Lond—Oct. 1, 1897. No. 15930 A.

Elevator.

Grain Elevator and Warehouse at Copenhagen. (Silo- und Bodenspeicher der Freihafen-Gesellschaft in Kopenhagen.) Description of this important structure with elevation and section. 1200 w. Oesterr Monatschr f d Oeffent Baudienst—Oct., 1897. No. 16-198 D.

Fireproof Construction.

The Best Fireproof Construction for Buildings Occupied for Mercantile Purposes. W. L. B. Jenney. Abstract of paper presented to the Fire Underwriters' Assn., giving suggestions that, if followed, would permit but little injury to the building other than smoking the walls and ceilings and blistering the paint. 5700 w. Eng Rec—Oct. 9, 1897. No. 15900.

Hotel.

The Astoria Hotel, New York City. Illustrated description of the Waldorf-Astoria hotel, as the completed structure will be called. 3000 w. Sci Am—Oct. 30, 1897. No. 16175.

Portable Buildings.

The Docker Pavilions. (Les Pavillons Docker.) Several forms of portable houses are illustrated and described, those shown being especially adapted for hospitals, and for temporary purposes in hot climates. Serial. Part I. 2500 w. La Revue Technique—Oct. 10, 1897. No. 16178 D.

Principles.

General Principles of Construction. Part first deals with materials and stability. 1300 w. Nat Build—Sept., 1897. Serial. 1st part. No. 15784 C.

Problems.

Some Important Problems in Construction. William W. Crehore. Discussing what should not be done; with reasons. Part first treats of the respective merits of cast iron and of built-steel columns in skeleton fire-proof construction. Ill. 1800 w. Br Build—Oct., 1897. No. 16-144 C.

School.

The New Buildings for the Royal Technical High School at Aix-la-Chapelle. (Der Neubau an der Königlichen Technischer Hochschule zu Aachen.) Elevation and plans of new buildings for the departments of mining and electrotechnics; costing $120,000. 1200 w. 1 plate. Glückauf—Sept. 18, 1897. No. 15854 B.

Tall Buildings.

The American Tall Building from a European Point of View. S. Henbest Capper. From an artistic standpoint the tall building is condemned when considered merely as a striving for "tallness." For a flat city like New York the sky line is improved. Lavish decoration is deemed inappropriate. Illustrations of notable European buildings are given for comparison. 3500 w. Engineering Magazine—Nov., 1897. No. 15-591 B.

University Buildings.

A Western City of Learning. Samuel E. Moffett. Explains the scheme of the University of California, aiming to secure the most artistic collection of buildings possible for the beautiful site at Berkeley, Cal. 4000 w. Harper's Wk—Sept. 11, 1897. No. 15027.

HEATING AND VENTILATION.

Penitentiary.

Heating and Ventilation of the Tennessee State-Penitentiary. Illustrated detailed description of plant furnished by the American Blower Co. 1000 w. Eng Rec—Oct. 9, 1897. No. 15901.

Radiation.

Heat Imparted from Surfaces with Various Temperature Differences. Leicester Allen. Reply to a correspondent desiring to know the number of British thermal units given off per square foot of direct-radiating surface per hour in a hot-water system and by steam radiation, under stated conditions, with information on the computation of heating effect. 1200 w. Heat & Ven—Oct. 15, 1897. No. 16073.

Railway Station.

Method of Heating Buildings where Three or More Stoves are Now Used. Report of committee as to best substitute for stoves in warming railway stations. 2500 w. Am Assn of Ry Supts of Bridges and Buildings. No. 15943 D.

Railway Ventilation.

See Railroad Affairs, Miscellany.

Senate Chamber.

Ventilating the United States Senate Chamber. A full description of the changes made to remedy the defects of the system installed. Ill. 3500 w. Eng Rec—Oct. 16, 1897. Serial. 1st part. No. 16058.

St. Louis Coliseum.

Heating and Ventilation of the St. Louis, Missouri, Coliseum. Illustrated description of the plant installed in a very large building. 1200 w. Heat & Ven—Oct. 15, 1897. No. 16072.

LANDSCAPE GARDENING.

Conifers.

Notes on Cultivated Conifers. C. S. S. Results of observations on cultivated conifers in the northern and eastern United States, including the Yew family. 1800 w. Gar & For—Oct. 6, 1897. Serial. 1st part. No. 15758.

English Gardening.

Penshurst Place. Brief description of the park and garden of this beautiful place in Kent. 1100 w. Gar & For—Oct. 6, 1897. No. 15757.

PLUMBING AND GASFITTING.

Factory Plumbing.

Plumbing in a New York Factory. Part first gives a general description, with requirements and arrangements of pipe lines and branches, roof tanks, cold water distribution and basement drainage pumping. Ill. 1300 w. Eng Rec—Oct. 2, 1897. Serial. 1st part. No. 15742.

Fatigued Metal.

Fatigued Metal. Edwin S. Marsh. Explains the cause of weakening of metals, which is one of the defects of house-plumbing. 800 w. Dom Engng—Oct , 1897. No. 16042 C.

Flushing.

A New Flushing System for Water Closets. Illustrated description of a system dispensing with the overhead tank, and substitutes the pressure of air in a vertical pipe about 3 ins. in diameter, its upper end closed. 800 w. Eng News—Oct. 21, 1897. No. 16084.

Report.

Plumbing Affairs at Washington, D. C. Annual report of the superintendent of the district plumbing service. 1400 w. San Plumb—Oct. 1, 1897. No. 15749.

Ventilation.

How Electricity May be Utilized to Advantage for the Local Ventilation of Plumbing Fixtures. James L. Lawler. Illustrated description, showing that the electric heater is the most practical, safest and best method of producing local ventilation. 1500 w. Dom Engng—Oct., 1897. No. 16041 C.

MISCELLANY.

Address.

President's Address before the Liverpool Architectural Society. W. E. Willink. Consists largely of a review of matters of interest since the formation in 1848. 5000 w. Builder—Oct. 9, 1897. No. 16060 A.

Belgium.

Review of the Architecture in Belgium. (Revue de l'Architecture en Belgique.) Charles Buls. Interesting illustrated description showing the influences that have affected the buildings in different localities. 2000 w. Jour of Roy Inst of Brit Arch—Sept. 23, 1897. No. 16107 D.

Byzantine Architecture.

Byzantine, or Early Christian Architecture. Cyrus K. Porter. Gives a brief general outline of the history of Byzantium, the early introduction of christianity and the customs of the time; the development of the architecture, and the countries influenced by it. 5500 w. Stone—Oct., 1897. No. 16103 C.

Churches.

The Country Church in America. William B. Bigelow. Churches of the United States, dating from 1630, are described and illustrated, and many interesting suggestions of church architecture are given. 5000 w. Scribner's Mag—Nov., 1897. No. 16114 C.

Competitions.

The Legal Status of the Pennsylvania Capitol Competition. Text of the opinion of Judge Simonton, sustaining the demurrer of four of the five State Capitol Commissioners, and dissolving the temporary injunction in the equity proceedings. 5000 w. Eng Rec—Oct. 23, 1897. No. 16129.

Draughtsmen.

Professional Draughtsmen as Special Students in the School of Architecture. William R. Ware. Explains why this class of students are admitted and the advantages and disadvantages to those most interested. 2700 w. Sch of Mines Quar—July, 1897. No. 16162 D.

Elevator.

A Traveling Staircase. (Un Escalier qui Marche.) Illustrated description of an inclined traveling way for general public use in the Magasins du Louvre at Paris. 1000 w. Le Génie Moderne—Sept. 15, 1897. No. 15833 B.

Exposition.

Review of the Works of the Exposition of 1900. (Exposition de 1900, Revue des Travaux.) Describing and illustrating the demolition of the old Palais de l'Industrie and the construction of the foundations of the new buildings in the Champs-Elysées. 2000 w. Le Génie Civil—Aug. 14, 1897. No. 15808 D.

The New Work in the Munich Crystal Palace. (Die Neuen Einbauten in den Münchener Glaspalast.) Showing the elaborate interior improvements and decorations made in connection with the international art exhibition at Munich. 4500 w. 2 plates. Oesterr Monatschr f d Oeffent Baudienst—Sept., 1897. No. 15850 D.

The Stockholm Exposition. (L'Exposition de Stockholm.) General description, with photographs of buildings and grounds. 1500 w. La Revue Technique—Sept. 25, 1897. No. 15585 D.

Fire Damage.

Behavior of Non-Fireproof Steel Building Construction in the Detroit, Mich., Fire. Frank M. Dunlap. Showing the excellent resistance made by the steel structure and describing the effect upon various kinds of construction, with photograph. 700 w. Eng News—Oct. 14, 1897. No. 15976.

Fireproofing.

Fireproofing Under Fireproofing Laws. Calls attention to the weak points that are allowed by architects, and advocates the use of terra-cotta as a protection of iron and steel frames. 2000 w. Br Build—Oct., 1897. No. 16145 C.

Floors.

Uniform Safe Loads for Building Floors. F. E. Kidder. Read before the convention of the International Assn. of Building Inspectors, at Detroit, Mich. Gives the writer's opinions and gives a summary of what he believes combines absolute safety with proper allowance for economy. 2200 w. Arch & Build—Oct. 16, 1897. No. 16018.

German Architecture.

Ecclesiologia Germanica. T. Francis Bumpus. Impressions obtained during a short tour among the old cities and towns of Westphalian-Prussia and Thuringian-Saxony. Ill. 2800 w. Arch, Lond—Oct. 8, 1897. Serial. 1st part. No. 16024 A.

Historic Churches.

Some Historic Churches of America. Thomas Morgan Prentice. Historical review, with illustrations, of many noted churches, with interesting references to their architecture. 6000 w. Harper's Wk—Oct. 23, 1897. No. 16077.

Illinois Legislature.

Architecture a "Close" Profession in Illinois. A bill for an act to provide for the licensing of architects and regulating the practice of architecture as a profession. 3000 w. Eng News—Oct. 21, 1897. No. 16090.

Kitchens.

The Kitchen. Editorial article on good arrangement and fittings. 1000 w. Nat Build—Sept., 1897. No. 15785 C.

Mausoleum.

The Grant Mausoleum, New York. Editorial discussion of mausoleums in general, with criticism of the architecture of the tomb named. 2500 w. Builder—Sept. 25, 1897. No. 15713 A.

Monument.

The William I Monument at the Porta Westphalica. Description with illustration, and account of the changes made from the original plan. 900 w. Sci Am—Oct. 9, 1897. No. 15767.

Mortars.

The Use of Wet Sand in the Making of Mortars. P. Hervieu. Translated from *Nouvelles Annales de la Construction*. Retards the setting by inducing the formation of aluminate of lime, and affects the volume. Results of experiments. 800 w. Br Build—Oct., 1897. No. 16146 C.

Renaissance.

Renaissance Architecture. T. Roger Smith. Opening lecture of the Architectural Classes delivered at University College, London. Explains what is meant by "Renaissance," describes typical buildings, and gives an outline of this extensive subject. 5700 w. Arch, Lond—Oct. 8, 1897. No. 16023 A.

Sheffield.

The Architecture of Our Large Provincial Towns. Sheffield, England. Interesting illustrated description of the place and its architecture. 6000 w. Builder—Oct. 9, 1897. No. 16059 A.

Tall Buildings.

The Modern Tall Building. Owen Brainard. Reasons for this class of architecture, its development, design, and novel features. Ill. 3000 w. Chau—Nov., 1897. No. 16224 C.

Training.

The Educational Training of Architects.—A Rejoinder. Leopold Eidlitz. A reply to the discussion of a paper read before the Royal Institute March 1, 1897, answering the criticisms advanced by different speakers. 6000 w. Jour Roy Inst of Brit Arch—Sept. 23, 1897. No. 16108 D.

Wall Decoration.

Gesso Work and "Fillings." Walter J. Pearce. Illustrated description of this class of work. 1800 w. Plumb & Dec—Oct. 1, 1897. No. 16025 A.

CIVIL ENGINEERING.

BRIDGES.

Arches.

Calculation of the Thrust of Arches. (Note sur le Calcul de la Poussée des Voûtes.) M. Tourtay. Giving simple formulas and a table of coefficients by means of which the thrust can be determined for segmental arches of known loading. 3000 w. Ann des Ponts et Chausseés—Part II, 1897. No. 15877 F + G.

The Influence of an Inclined Load Line upon a Symmetrical Arch (Einfluss Geneigter Nivelletten auf Symmetrische Gewölbe.) An elaborate analytical investigation, showing the magnitude and direction of stresses for a given loading. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—October 8, 1897. No. 16192 B.

Beam.

Investigation of the Maximum Efforts Developed in a Horizontal Beam of Single Span by the Passage of a Train. (La Recherche des Efforts Maxima Développés en un Point dans une Poutre Horizontale à une Travée par le Passage d'un Train.) An analytical investigation by M. G. Rogie. 5500 w. Ann des Ponts et Chaussées—Part II, 1897. No. 15876 F + G.

Design.

The Esthetics of Bridge Design as Exemplified by Two Recent New York Bridges. Alfred P. Boller. An interesting article on this subject, with views of the Central Bridge and Harlem Ship Canal Bridge at Kingsbridge Road, New York. 2400 w. Eng News—Oct. 7, 1897. No. 15771.

Drawbridge.

Plate-Girder Swing Bridge at Ottawa, Illinois. Illustrated description of a bridge on the C. B. & Q. railroad, crossing the Illinois and Michigan canal, the special features of construction necessary to adapt it to its low position being of interest. 700 w. Ry Rev—Oct. 16, 1897. No. 16064.

Swing Bridges on the Chicago Drainage Canal. Specifications and conditions for some of the bridges for which bids are now invited. Diagrams are given showing the truss outlines, and a few typical maximum strains and sections. 800 w. Eng Rec—Oct. 2, 1897. No. 15741.

The Tower Bridge at London. (Le Pont de la Tour, à Londres.) A very good account of the Tower bridge over the Thames, discussed from a French point of view. With plate of details of the bascules and hydraulic machinery for operating them. 3500 w. 1 plate. Le Génie Civil—September 25, 1897. No. 16182 D.

Failure.

An Instructive Failure of a Highway-Bridge Abutment. W. L. Cowles. The failure of the Washington street bridge in Pottsville, Pa., is described and illustrated. 1000 w. Eng News—Oct 14, 1897. No. 15975.

Fall of a Bridge at Tarbes. Editorial criticism of the construction and the cause of the failure in France. 2300 w. Engr, Lond—Sept. 24, 1897. No. 15689 A.

The Failure of the Adour Bridge at Tarbes. (La Rupture du Pont sur l'Adour à Tarbes.) A very full account, with numerous illustrations, of the failure of the steel girder bridge at Tarbes, France, while undergoing test just after completion. 4500 w. Le Génie Civil—July 31, 1897. No. 15802 D.

Floors.

See Railroad Affairs. Maintenance of Way.

Foundations.

The Foundation Caissons for the Bridge Alexander III. (Caissons de Fondation du Pont Alexandre III.) Illustrated description of the construction and launching of the great caissons for the shore foundations of the new bridge over the Seine, at Paris. 5000 w. 1 plate. Le Génie Civil—September 11, 1897. No. 15814 D.

Framework.

Computations for Double-Hinged Arch Frames under Horizontal and Inclined Forces. (Berechnung des Zweigelenkbogens unter Einwirkung Wagerechter und Schräger Kräfte.) An analytical and graphical discussion of the action of framed structures with especial reference to wind stresses. 3500 w. Zeitschr d Oesterr Ing u Arch Ver—October 1, 1897. No. 16191 B.

Germany.

Recent German Bridges. (Neuere Deutsche Brückenbauten.) With photographs of bridges now in course of erection and elevations of the large bridges and viaducts of recent design. A valuable article by Prof. Foerster of Dresden. 6000 w. Stahl und Eisen—September 15, 1897. No. 15846 D.

Niagara.

Bridges Across the Niagara. Brief account with illustrations. 500 w. St Ry Rev—Oct. 15, 1897. No. 15984 C.

Paris.

The Alexander III Bridge over the Seine at Paris. (Die Brücke Alexander III über die Seine in Paris.) A very full description from a special correspondent, with plates of details. 5000 w. 2 plates. Oesterr Monatschr f d Oeffent Baudienst—October, 1897. No. 16196 D.

Quebec.

Proposed Bridge Across the St. Lawrence River at Quebec. Information of site and plans for the construction of a railway bridge, with estimate of cost, general dimensions, and other particulars. 1200 w. Eng News—Oct. 14, 1897. No. 15977.

Replacing Bridge.

See Railroad Affairs, Maintenance of Way.

Rolling Bridge.

The Rolling Bridge at Cherbourg. (Le Pont Roulant de Cherbourg.) Describing and illustrating the new bridge at the Cherbourg docks. The bridge is drawn back by hydraulic power. 2000 w. Le Génie Moderne—October 1, 1897. No. 15836 B.

St. Lawrence Bridges.

Bridges over the St. Lawrence for the New York and Ottawa. Brief illustrated description of two bridges being constructed from Cornwall, Ont., to a point near Hogansburg, N. Y. The channel is divided by an island which is also crossed on an embankment about three-quarters of a mile long. 700 w. R R Gaz—Oct. 1, 1897. No. 15683.

Viaduct.

The J. F. Lépine Bridge over the Northern Railway of France. (Pont J. F. Lépine sur la Tranchée du Chemin de fer du Nord.) Describing the placing of the trusses of a street viaduct over a wide railway cutting in Paris. The completed bridge was pushed bodily over a span covering 10 tracks without interrupting travel. 5000 w. 1 plate. Le Génie Civil—September 4, 1897. No. 15812 D.

The Saint Bernard Bridge. (Le Pont Saint Bernard.) An illustrated account of the erection of a truss bridge at rue Lépine over a cutting of the Northern Railway of France at Paris. A pair of bowstring trusses were pushed over a cutting 132 feet wide without interrupting traffic beneath. 2500 w. La Revue Technique—October 10, 1897. No. 16176 D.

Victoria Bridge.

The New Victoria Highway Bridge, Brisbane, Australia. Photographs and description of a new six-span, highway bridge, with account of its construction. 1500 w. Eng News—Oct. 7, 1897. No. 15770.

CANALS, RIVERS AND HARBORS.

Caisson.

Movable Caisson for Repairing Dock Walls. (Caisson Mobile pour la Réparation des Murs de Quais.) Describing the appliances used for repairing the walls of the docks at Calais, under water. 3500 w. 1 plate. Ann des Ponts et Chaussées—Part I. 1897. No. 15872 F+G.

Channel.

Cutting a Channel through the Charpentier Bar. (Le Creusement d'un Chenal à travers la

Barre des Charpentiers.) M. de Joly. The official account of the works at the mouth of the Loire; with hydrographic charts, details of dredging machinery, &c. 17500 w. Two plates. Ann des Ponts et Chaussées—Pt. I, 1897. No. 15869 F+G.

Chicago Canal.

Progress of Work on the Chicago Drainage Canal. Table showing the amount of work done up to Sept. 1st, 1897, on each of the several contracts, and the amount of work remaining to be done. From report of Mr. Isham Randolph, chief engineer. 500 w. Eng News—Sept. 30, 1897. No. 15658.

Colombo.

The Colombo Harbor Works. History of the various improvements made, especially the recent work which has made this one of the finest artificial harbors in the world. Map. 2800 w. Ind Engng—Sept. 4, 1897. No. 15781 D.

Cranes.

The Electric Cranes at the Port of Havre. (Les Grues Electriques du Port du Havre.) Illustrated description of four radial electric cranes mounted on gantries on the Quai Colbert at Havre, with an account of the tests to which they were subjected. 3500 w. Le Génie Civil—September 18, 1897. No. 15818 D.

Dams.

Needle Dams. (Les Barrages à Aiguilles.) Describing the difficulties in operating the movable dams on the Meuse, and the improvements devised by M. Baudisson. 4500 w. 1 plate. Ann des Ponts et Chaussées—Part II. 1897. No. 15875 F+G.

Profiles for Masonry Dams. (Profils des Barrages en Maçonnerie.) M. Pelletreau. An analytical investigation of ordinary profiles and suggestions of a method of reinforcement giving greatly increased strength. 30000 w. 1 plate. Ann des Ponts et Chaussées—Pt I, 1897. No. 15868 F+G.

Gauging.

Gauging and Measuring the Flow of Water. (Wasseraichungen und Ueberfallmesssungen.) With illustration and description of the measuring tanks and weir used at the Kaiserbrunnen near Vienna; using the Bazin formula. 3000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—September 17, 1897. No. 15830 B.

Haulage.

Experiments of the Danube Navigation Company. (Expériences faites par la Société de Navigation sur le Danube.) An account of the dynamometric tests of the resistance of boats to haulage under various loads and speeds. 2000 w. Le Génie Civil—July 31, 1897. No. 15803 D.

See also Electrical Engineering, Power.

Lighthouse.

The Construction of the Raz-Tina Lighthouse. (La Construction du Phare de Raz-Tina.) M. Regnoul. Description with plate of details of this important new work at the port of Sfax in Tunis. 4000 w. 1 plate. Ann des Ponts et Chaussées—Pt. I, 1897. No. 15870 F+G.

The "Eckmühl" Lighthouse. (Le Phare d'Eckmühl.) A description of the fine new lighthouse erected on the Point de Penmarc'h, France, with plate of details of lighting apparatus, and pneumatic siren. 7500 w. 1 plate. Le Génie Civil—October 9, 1897 No. 16185 D.

Lock Gates.

Details of Gates for the Cascades Canal Lock. Drawings showing the details of construction of these great gates. 100 w. Eng News—Oct. 28, 1897. No. 16211.

The Gates of the Cascades Canal Lock, Columbia River, Oregon. Interesting account of the canal built to overcome obstructions in this river, with special illustrated description of the lock and guard-gates. 2500 w. Eng News—Oct. 21, 1897. No. 16087.

Locks.

Machinery for Operating Locks of the St. Mary's Falls Ship-Canal. Illustrated description of the mechanism for opening and closing the gates and for controlling the culverts in this noted canal of the United States. 1100 w. Marine Engng—Oct., 1897. No. 15911 C.

Nicaragua.

The Clayton-Bulwer Treaty. Mayo W. Hazeltine. This treaty, which declared that a canal crossing the Nicaragua isthmus should remain forever under the joint control of the United States and Great Britain, is discussed, with actions bearing upon it, and whether it has been rendered voidable. 3000 w. N Am Rev—Oct., 1897. No. 15724 D.

Paris.

Paris a Seaport. (Paris Port de Mer.) A revival of the scheme for a ship canal between Rouen and Paris. 1500 w. La Revue Technique—Sept. 25, 1897. No. 15586 D.

Shears.

Shears of 80 Tons Capacity at the Port of Bordeaux. (Bigue de 80 Tonnes du Port de Bordeaux.) Detailed description with plate of illustration; the inclination and hoisting are effected by direct-acting hydraulic cylinders, with an auxiliary tackle for light loads. 1500 w. 1 plate. La Revue Technique—Sept. 25, 1897. No. 15584 D.

Spree.

The River Spree at Berlin. (Die Spree in Berlin.) Official account of the river improvements and canalization in Berlin and vicinity. 7500 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—September, 1897. No. 15849 D.

Ship Canal.

The Proposed Florida Ship Canal. Information of the proposed construction of this canal, with the arguments in its favor. 1700 w. Bd of Trade Jour—Oct., 1897. No. 16220 A.

Tide Gauge.

A Registering Tide- and Rain-Gauge. (Ueber einen Registrirenden Pegel und Regenmesser.) A column of water is sustained by atmospheric pressure and the variations of pressure due to varying levels operates the registering pencil. 1800 w. Zeitschr d Oesterr Ing u Arch Ver—October 8, 1897. No. 16193 B.

Towage.

The Cable Towage of Boats. (Le Halage Funiculaire des Bateaux.) Describing the cable system devised by M. Maurice Lévy for towing the boats through the Mont-de-Billy tunnel on the canal between the rivers Aisne and Marne. 7500 w. 1 plate. Ann des Ponts et Chaussées —Part II, 1897. No. 15874 F+G.

Weirs.

The Recent Investigations of Bazin on the Flow of Water over Weirs. (M. Bazin's Neuere Untersuchungen über den Abfluss an Ueberfallen.) A very full abstract of Bazin's most recent hydraulic experiments with tables, diagrams and formulas. 9000 w. Oesterr Monatschr f d Oeffent Baudienst—September, 1897. No. 15852 D.

Weser.

Improvement Works on the River Weser. (Wasserbauten an der Weser.). A. Herbst. A description, based upon a personal tour of inspection by the official engineer of the Austrian Department of the Interior, with plate of channel sections and topographical map. 4500 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—October, 1897. No. 16195 D.

Wharf Improvement.

Modern Wharf Improvements and Harbor Facilities. Foster Crowell. Devoted largely to American coal handling plants; also giving plans of docks at Antwerp, Hamburg, Dunkerque, Marseilles, and Glasgow. The defects of American harbors are compared with the superior arrangements of the European ports. 5000 w. Engineering Magazine—Nov., 1897. No. 15589 B.

IRRIGATION.

Dam.

The Construction of the Hemet Dam. James D. Schuyler. An account before the Technical Society of the Pacific Coast, of the construction of this high masonry dam in California. The water supply is used for irrigating over a thousand acres. Discussion follows. Ill. 7000 w. Jour Assn of Eng Soc—Sept., 1897. No. 15990 C.

Ogden, Utah.

See Electrical Engineering, Power.

MISCELLANY.

Address.

Presidential Address before the Architectural Association. Hampden W. Pratt. Reviews the fifty years work of the association. 6500 w. Arch, Lond—Oct. 15, 1897. No. 16155 A.

Beams.

The Ultimate Strength of Concrete-Steel Beams. J. B. Johnson. Abstracted from a paper read before the Detroit meeting of the American Assn. for the Advancement of Science. Gives assumptions and equations derived. 500 w. Eng News—Oct. 21, 1897. No. 16086.

Cement.

The Growing Importance of Cement in Constructive Work. Edward Wilkins Dewey. The reduced price of German Portland cement and the improvement in the American product is causing a great increase in use. Rosendale cement and English imported are being crowded out. The relation of domestic production to imports is tabulated and a great increase in consumption predicted. 4500 w. Engineering Magazine—Nov., 1897. No. 15594 B.

Clay.

Improved Furnace for Drying Clay, (Nouveaux Fours pour le Séchage de l'Argile.) Describing and illustrating the Toldt oven, in which the masses are turned as they descend inclined planes. 1500 w. 1 plate. Le Génie Civil—September 18, 1897. No. 15819 D.

Rock Drill.

The Siemens & Halske Electric Rock Drill. (Der Elektromotor—Schlagbohr maschine, System Siemens & Halske.) Describing especially the use of the drill in the Nassbach tunnel in Austria. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—September 3, 1897. No. 15827 B.

Wagon Roads.

A Steel Trackway for Wagon Roads. Illustrated description of experiments being made by the United States Department of Agriculture to determine the practicability of steel trackways. The object is to furnish a wear-resisting surface, reduce the expense of maintenance, and the labor of hauling heavy loads. 1600 w. Ir Age —Oct. 7, 1897. No. 15751.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

Coal Trade.

The Expansion of the American Coal Trade. Extracts from a pamphlet written by Joseph W. Burke, under the title of "A Great National Question," dealing with this subject, and showing the extent and value of the Great-Warrior coal-fields in Alabama, with comments. 1500 w. Mfrs Rec—Oct. 15, 1897. No. 16017.

Combination.

A Possible Bituminous-Coal Combination. Remarks on the results of the settlement of the soft-coal miners' strike in the United States, and the probability of an alliance to benefit the bituminous trade. 1100 w. Bradstreet's—Oct. 9, 1897. No. 15783.

Communities.

The Free Communities of Miners in Manchuria. (Les Communautés Libres de Mineurs en Mandchourie.) R. de Batz. An interesting account of the independent organizations among the gold miners of China, having local government, systems of working and sufficient strength to be practically free of the Imperial authority. 1800 w. Le Génie Civil—September 25th, 1897. No. 16184 D.

Competition.

American Competition. (La Concurrence Américaine.) A review of the development of the American iron trade from a French point of view, condensed from a study by M. Traseuster in the Revue Universelle des Mines. 2500 w. Le Génie Civil—September 18, 1897. No. 15820 D.

British Trade and Foreign Competition. Editorial on the information furnished by the publication of returns from the colonies, noting some of the causes of the displacement of British goods, and calling attention to some points of detail. 1400 w. Builder—Oct. 16, 1897. No. 16149 A.

Future Supremacy in the Iron Markets of the World. J. Stephen Jeans. The opening of the Lake Superior Region, the improvements in machinery and methods and especially the greater value of high priced labor, give the American iron industry controlling advantage in the competition with European manufacturers. 4800 w. Engineering Magazine—Nov. 1897. No. 15588 B.

The Utility of Competition. Calls attention to the fact that competition stimulates improvements, improves the quality and cheapens the cost of goods, gives larger wages and steadier employment. 1500 w. Clay Rec—Sept. 28, 1897. No. 15736.

Cost Keeping.

See same title under Mechanical Engineering, Shop & Foundry.

Education.

A Comparison of Courses in 17 German Technical Schools. (Vergleichende Zusammenstellung aus den Programmen von 17 Deutschen Technischen Fachschulen.) With an elaborate chart showing the proportion of time given to various studies, giving a full discussion of the subject from the German standpoint. 10000 w. Zeitschr ver Deutscher Ingenieure—September 11, 1897. No. 15822 D.

Export Duty.

The Proposed Export Duty on Canadian Ores. Suggestions from the standpoint of the interests of Canada. Considers that these duties, at this time, would be detrimental to Canada. 1500 w. Can Min Rev—Sept., 1897. No. 15717 C.

Exposition.

The Present Condition of Preliminaries for the Paris Exposition of 1900. (Ueber den Heutigen Stand der Vorarbeiten für die Weltausstellung in Paris 1900.) A discussion by Prof. Exner before the Austrian Society of Engineers of the best method of making an exhibit under the special classification adopted for this Exposition. 5000 w. Zeitcher d Oesterr Ing u Arch Ver—September 10, 1897. No. 15828 B.

Germany.

England's Opportunity in Germany. Comment on the sale of the North-German Lloyd fleet of seven steamers, which have been employed in the trade between the Weser ports and the United Kingdom, the effect on British shipping and on trade. 600 w. Trans—Sept. 24, 1897. No. 15709 A.

The Trade of Germany. Editorial on the danger of injuring British trade with continental and other countries, while striving to extend trade with the colonies and the far east. Calls attention to points in consular reports. 1300 w. Engng—Sept 24, 1897. No. 15686A.

Meat Shipment.

Preservation of Meat by Freezing Processes. (Conservation des Viándes par les Procédés Frigorifiques.) Report of M. Deiss upon an inspection of British methods of shipping meat for long distances, with details of cost. 2500 w. Le Génie Civil—Sept. 11, 1897. No. 15817 D.

Museum.

A Commercial Museum. Information of the collection and arrangement of the world's production at the Philadelphia Commercial Museum, in its temporary quarters, and of the location and cost of the building being constructed to receive it. 3000 w. Harper's Wk—Oct. 9, 1897. No. 15715.

Regulations for the Commercial Samples Museum in Japan. From the *Japan Weekly Mail*. Information of the samples that may be exhibited, and rules affecting them. 700 w. Bd of Trd Jour—Oct., 1897. No. 16221 A.

Prices.

The Causes of the Fall in Prices Since 1872. Jeremiah W. Jenks. Address before the New York State Bankers' Assn. A consideration of earlier causes of changes in general prices, the arguments of writers on all sides, with conclusions from the study. 8000 w. Bankers' Mag, N Y—Oct., 1897. No. 15978 D.

South Africa.

The Commercial and Industrial Situation in the South African Republic in 1896. (Situation Commerciale et Industrielle de la République Sud-Africaine en 1896.) Abstract of a report of the French consul, with statistics and map. 2500 w. Le Génie Civil—Aug. 7, 1897. No. 15807 D.

Tariff.

Canada and the Dingley Bill. John Charlton. A brief outline of the character and capabilities of Canada is given, the desirability of close commercial relations between this country and the United States is discussed, the effect of the Dingley bill on the free list, and the advantage to both countries of intimate trade relations. 4000 w. N Am Rev—Oct., 1897. No. 15721 D.

New Cuban Tariff and British Trade. Memoranda respecting the changes which have been made by the new Cuban tariff in the duties on the principal articles which Cuba imports from Great Britain and British possessions. 1800 w. Bd of Trd Jour—Oct., 1897. No. 16222 A.

Tariff Changes and Customs Regulations. United Kingdom and France, Bulgaria, Russia, Norway, Germany, Algeria, Guiana, Ivory Coast, Spain, Switzerland, Costa Rica, Guatemala, United States of Colombia, Cyprus, British India, British Honduras, Dominica and Victoria. 6000 w. Bd of Trd Jour—Oct., 1897. No. 16223 A.

Trade Unionism.

The Effects of Trade Unionism upon Skilled Mechanics. Hiram S. Maxim. Trade unionism results in opposition to modern machinery and methods, dulls and retards the skilled mechanic and is detrimental to the country by curtailing the output and delivering the industries into the hands of competing nations of independent workmen. Many forcible illustrations from personal experience are given. 3500 w. Engineering Magazine—Nov., 1897. No. 15587 B.

Union Label.

Another View of the Union Label. Starr Hoyt Nichols. Briefly reviews the article of Miss M. E. J. Kelly, in a recent number of this publication, and presents quite opposite views. Holds that the label is a device to make the boycott more efficient. Examines the methods used by its promoters in the United States. 5000 w. N Am Rev—Oct., 1897. No. 15722 D.

Winter Load Line.

North Atlantic Freeboards. Editorial discussion of the trade complications growing out of the North Atlantic winter restrictions in loading of vessels. 1400 w. Engr, Lond—Sept. 24, 1897. No. 15688 A.

CURRENCY AND FINANCE.

Gold Standard.

The Austro-Hungarian Bank, and the Adoption of the Gold Standard in Austria. Charles A. Conant. The history of banking in this country and a study of the effects of a depreciated paper currency. 5500 w. Bankers' Mag, N Y—Oct., 1897. Serial. 1st part. No. 15979 D.

Indian Currency.

The Indian Currency Position. Hermann Schmidt. Discussing the new Indian monetary policy, and concluding that it is not settled thus far. 2000 w. Bankers' Mag, Lond—Oct., 1897. No. 16104 A.

Legislation.

What Legislation is Needed with Respect to the United States Currency. N. B. Van Slyke. Address at the annual convention of the American Bankers' Assn. An outline of the writer's views, and suggestions. 1500 w. Bankers' Mag, N Y—Oct., 1897. No. 15981 D.

Royal Mint.

The Report of the Royal Mint. Information of interest relating to the coinage of the British Empire, and comparing other countries. 2300 w. Bankers' Mag, Lond—Oct., 1897. No. 16105 A.

Silver Question.

India's Case for Silver. A. S. Ghosh. States the present condition of affairs in this country, resulting from the closing of the mints, and considers what would be the effect if silver were restored to its former value. 3500 w. N Am Rev—Oct., 1897. No. 15727 D.

Present Status of the Silver Question. Richard P. Bland. A paper advocating the free coinage of silver. 3000 w. N Am Rev—Oct., 1897. No. 15726 D.

GOVERNMENT CONTROL.

Corporations.

The Powers and Privileges of Corporations versus the Rights of the People. Austin W. Wright. Part first calls attention to the fact that all the powers of corporations were granted by the people themselves, through their chosen representatives, and suggests the course necessary to correct the mistakes made, discussing the subject generally. 4800 w. Elec Engng—Oct. 15, 1897. Serial, 1st part. No. 16054.

LABOR.

Eight-Hours Day.

The Eight-Hours Working Day. An endeavor to look at the position from both sides of view and to examine the facts of the case. 1800 w. Elec, Lond—Sept. 24, 1897. No. 15710 A.

Immigration.

Immigration and the Educational Test. Prescott F. Hall. Discussion of this question, showing how undesirable are the masses who come to the United States, and the effect upon labor, and the general good. Recommends a reading and writing test for admission. 4000 w. N Am Rev--Oct., 1897. No. 15719 D.

Legislation.

Democracy and the Laboring Man. F. J. Stimson. An outline of the legislation, concerning labor, existing in various parts of the United States, which has been enacted in the past ten years, discussing what can be accomplished by wise and proper legislation. 10000 w. Atlantic M—Nov., 1897. No. 16116 C.

Organization.

Free Labor versus Trade Unionism. States the object of the National Free Labor Association, which has recently held a successful meeting in London. 2000 w. Engr, Lond—Oct. 15, 1897. No. 16137 A.

Machinery.

Man and the Machine. Henry C. Potter. The writer explains the circumstances under which he made remarks which have been greatly misrepresented by the press, and gives his opinion of the effect on the worker of the employment of machinery in manufacture, urging the amelioration of the conditions. 3300 w. N Am Rev—Oct., 1897. No. 15718 D.

Strike.

The Strike and the Lock-out. The present condition of the strike in England, especially the importance of Birmingham, and the policy adopted there, with its bearing on engineering troubles. Also editorial. 6800 w. Engr, Lond—Oct. 15, 1897. No. 16139 A.

Tools.

See Mechanical Engineering, Miscellany.

MISCELLANY.

Capital.

Organized Capital: Its Privileges and Its Duties. Harvey J. Hollister. Paper presented at the annual meeting of the American Bankers' Assn. Considers the privileges and duties of

the administrators of capital. 3800 w. Bankers' Mag, N Y—Oct., 1897. No. 15980 D.

Failures.

An Improving Record of Failures. A tabulated statement of business failures in the United States and Canada for nine months in two years, with assets and liabilities, and discussion. 1200 w. Bradstreet's—Oct. 2, 1897. No. 15674.

Millionaires.

What Millionaires Have Done. Lyman J. Gage. Extract from an address at Peoria, Ill. Showing the great benefits to society from the invested capital that they so often condemn. 1700 w. Bul of Am Ir & St Assn—Oct. 20, 1897. No. 16055.

Prosperity.

The Foundations of Our Growing Prosperity. Ossian D. Ashley. Outlines the causes of the depression in the United States, and the fundamental facts which constitute the basis of the revival in business. 4000 w. Ry Mag—Aug., 1897. No. 15677 C.

United States.

The Economic Situation in the United States. D. M. Frederiksen. Discusses the causes of the continuation of the hard times, the revival of business, the reform of the currency and various questions now before the American people. 3500 w. Bankers' Mag, Lond—Oct., 1897. No. 16106 A.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

Electrolysis.

Determination of Nickel and Cobalt in Iron and Steel. (Dosage du Nickel et du Cobalt dans les Fontes et les Aciers.) Giving an account of the electrolytic method of M. Ducru for the rapid and accurate determination of nickel and cobalt, with tables of results. 1000 w. La Revue Technique—Oct. 10, 1897. No. 15599 D.

Furnace.

The Electric Furnace and the Work of M. H. Moissan. (Le Four Electrique et les Travaux de M. H. Moissan.) A general review of Moissan's recently published work, with illustrations and details of the results obtained by him. Three articles, 7000 w. Le Génie Civil—Aug. 21, 28, Sept. 4, 1897. No. 15811 H.

Nickel.

The Electrolytic Winning and Refining of Nickel. Report of experiments of Dr. F. Foerster, as published in the *Zeitschrift für Elektrochemie*, with account of other work in this field. 1600 w. Elect'n—Oct. 8, 1897. No. 16061 A.

LIGHTING.

Arcs.

Notes on the Electric Arc. Thomas Hesketh. Comments on the lack of attention given to developing the arc lamp, and gives a study of the factors influencing the efficiency of the direct current arc. 4000 w. Elect'n—Sept. 24, 1897. No. 15702 A.

Engines.

Steam Engines for Electric-Lighting Purposes. John Davidson. Paper read before the Salford Science Students' Assn., at Salford, England. Remarks on a few of the main features of high-speed steam engines, and the difficulties met with in satisfactorily designing them. Ill. 1400 w. Mech Wld—Oct. 15, 1897. Serial. 1st part. No. 16121 A.

Hammersmith.

Hammersmith. Illustrated description of an English electric-light station, with history of the undertaking. 4200 w. Elec Eng, Lond—Oct. 1, 1897. No. 15925 A.

Hartford.

The Hartford Electric-Light and Power Plant. Illustrated description of the plant of a city using more electric light and power than any other in the United States. 1600 w. Sci Am—Oct. 9, 1897. No. 15766.

Isolated Plant.

A Model Isolated Plant. Illustrated description of a modern and complete plant installed for H. N. Higinbotham, at his country home near Joliet, Ill. 2300 w. W Elect'n—Oct. 2, 1897. No. 15737.

Lamps.

Relative Value of 220-Volt and 110-Volt Lamps. Francis W. Wilcox. Discussion of when it will pay to install a 220-volt system. 2800 w. Elec Wld—Oct. 2, 1897. No. 15740.

Station.

Electric-Lighting Station at Garfield Park, Chicago. Illustrated detailed description. 1700 w. Power—Oct., 1897. No. 15732.

Steamship Lighting.

The Lighting of the Steamship Kaiser Wilhelm der Grosse. Illustrated description of the fine lighting equipment, and power appliances. Also the three powerful telephones. 700 w. Elec Wld—Oct. 2, 1897. No. 15739.

Street Lighting.

See Municipal Engineering, Miscellany.

Tennessee.

The Electrical Features of the Tennessee Centennial. Illustrated description of some of the beautiful effects in lighting, and of the plant and applications for power. 1700 w. Elec Wld—Oct. 9, 1897. No. 15796.

POWER.

Centralization.

The Centralization of Electricity Supply for Lighting, Power, Tramways and General Purposes. Arthur Wright. Considers the question of adopting some combined arrangement for supplying electricity for various purposes, from one center. Also editorial. 4800 w. Elec Rev, Lond—Sept. 24, 1897. No. 15707 A.

Central Station.

Central Electric Station of the Davis Coal and Coke Company. Timothy W. Sprague. Describes an extensive plant in West Virginia installed for a company mining and shipping bituminous coal and manufacturing coke. 2200 w. Min Ind & Rev—Sept. 30, 1897. No. 15714.

Converters.

Rotary Converters and Their Uses. Louis Bell. Gives an informal description of their properties and uses, showing that the rotary converter furnishes the most efficient and u eful method of getting continuous from alternating currents. Discusses when and how it can be advantageously employed. 2500 w. Am Elect'n —Oct., 1897. No. 15788.

Cranes.

See Civil Engineering, Harbors. See also Marine Engineering.

Edison's Mine.

See Mining and Metallurgy, Iron and Steel.

Electrical Machinery.

Hints on the Care of Electrical Machinery. William Baxter, Jr. Difference between the two electric systems, the alternating and the continuous, and their relative merits. Ill. 3000 w. Power—Oct., 1897. No. 15733.

Haulage.

Electric Canal Haulage in France. From *l'Industrie Electrique*. Illustrated description of a system being installed in the Aire and Deule canal. 700 w. Elec Eng, N Y—Oct. 21, 1897. No. 16169.

See also Civil Engineering, Canals.

Insulation.

Insulators for Electric-Power Transmissions. T. A. W. Shock. Read before the Santa Cruz Convention of the Pacific Coast Electric Transmission Assn. Reports the experience with insulators on the lines of the Sacramento Electric, Gas and Railway Co. 900 w. Jour of Elec—Sept., 1897. No. 15903.

Insulators for Use on High Voltages. Henry D. Sears. Read before the Santa Cruz Convention of the Pacific Coast Electric-Transmission Assn. States the conditions to be fulfilled by a good insulator, and discusses the materials used, quoting extracts from standard authorities. 1600 w. Jour of Elec—Sept., 1897. No. 15905.

The Line Insulation of 16000 Volts. C. H. Van Norden. Read before the Santa Cruz Convention of the Pacific Coast Electric-Transmission Assn. A solution of the problem of insulation as attempted by the Central California Electric Co., with experience gained. 1000 w. Jour of Elec—Sept., 1897. No. 15902.

Line Construction.

The Construction of Transmission Lines. John S. Eastwood. Read before the Santa Cruz Convention of the Pacific Coast Electric-Transmission Assn. Discusses line location, materials, and construction. 2500 w. Jour of Elec—Sept., 1897. No. 15904.

Mine Transmission.

Latest Developments and the Practical Application of Alternating Multiphase Machinery for Electric Power Transmission. Walter Dixon. Paper read before the Federated Institution of Mining Engineers, discussing the applications to mining purposes. 2500 w. Ir & Coal Trds Rev—Oct. 1, 1897. No. 15931 A.

Montreal.

The Lachine Rapids-Montreal Electric-Power Transmission-System. Illustrated description of a large enterprise of great importance in the industrial developments of Canada. 1800 w. Elec Wld—Oct. 2, 1897. No. 15738.

Motive Power.

See Railroad Affairs, Transportation.

Niagara Falls.

The Extension of the Power Plant of the Niagara Falls Power Co. Orrin E. Dunlap. Description, with illustrations, of the extension of the power-house and wheel-pit, and other changes. 1100 w. Eng News—Oct. 14, 1897. No. 15967.

The Falls Harnessed. Historical account of the two power companies at the Falls of Niagara, with many illustrations. 5000 w. St Ry Rev—Oct. 15, 1897. No. 15985 C.

Ogden, Utah.

The Power Transmission Plant at Ogden. Illustrated description of an extensive plant laid out with the intention of supplying energy for light, power, and railway purposes, both in Ogden and Salt Lake City, Utah, and also for mining, and water for irrigation. 1600 w. Elec Wld—Oct. 16, 1897. No. 16048.

Printing.

Electric Power for Operating Printing and Binding Machinery. Reed R. Bishop. Abstract of a thesis presented to the faculty of Applied Science of Columbia University, New York City, for the degree of Electrical Engineer. Details in reference to the use of electric power for operating printing presses, cutters, folders, etc., including all machinery necessary for the production of a complete book. Ill. 1400 w. Elec Wld—Oct. 9, 1897. Serial. 1st part. No. 15798.

Switch Boards.

Three-Phase Switch-Boards, Apparatus and Synchronizing Methods. H. E. Raymond. Detailed description of a few cases which cover most of the ordinary requirements. 2000 w. Am Elect'n—Oct., 1897. No. 15787.

Transmission.

The Chambly Manufacturing Company's Electrical Power-Transmission Plant. Illustrated description of this fine installation, near Montreal, Canada. 1500 w. Elec Wld—Oct. 9, 1897. No. 15795.

The Electrical Power-Transmission Plant at Three Rivers, Quebec. H. R. Leyden. Illustrated description of the first long distance plant to be installed in Canada. 2200 w. Elec Wld—Oct. 9, 1897. No. 15797.

TELEGRAPHY AND TELEPHONY.

Cables.

A New Method of Localizing Total Breaks in

Submarine Cables. C. W. Schaefer. Interesting study of this problem, with description of the method the writer has found best. 5500 w. Elect'n, Lond—Oct. 15, 1897. No. 16143 A.

Cable Testing.

A Forgotten Method of Cable Testing. A. Tobler. Describes a method recalled by the perusal of a pamphlet published twenty-two years ago. The insulation resistance is tested by loss of charge. 900 w. Elec Rev, Lond—Oct. 8, 1897. No. 16051 A.

Calling Apparatus.

A Synchronous Calling-Apparatus for Telegraph Stations. Illustrates and describes an apparatus invented by H. Wetzer, by which each station may be called independently. 400 w. Elec Eng, Lond—Sept. 24, 1897. No. 15704 A.

Electric Lines.

Modern Construction and Maintenance of Electric Lines. William Brophy. Abstract of a paper read before the Mayor's Convention, Columbus, Ohio. Favors the underground construction, and discusses the overhead lines, fire and police telegraph-apparatus, &c. 1800 w. Elec Eng, N. Y.—Oct. 7, 1897. No. 15754.

Exchange.

The Construction and Working of a Typical Telephone Exchange. J. Wright. The object is to explain as simply and explicitly as possible the construction and mode of working of a small exchange on the English National Telephone Company's system as equipped at the present time. Ill. 2000 w. Elec Eng, Lond—Oct 1, 1897. Serial. 1st part. No. 15927 A.

History.

The Electric Telegraph. J. Warren. Historical account of the efforts to communicate by telegraph, dating from the sixteenth century. 2400 w. Elec, Lond—Oct. 15. 1897. Serial. 1st part. No. 16117 A.

Life Saving.

The Telephone in the Life-Saving Service. William Bolton. A letter from the superintendent of United States Telephone Lines Life-Saving Service, explaining the value of the instrument in the saving of life and property. 1400 w. Elec Rev, N. Y.—Oct. 6, 1897. No. 15763.

Patents.

Infringing Telephone Patents. G. S. Maxwell. Calling attention to the difficulty of securing the apparatus needed to equip telephone-exchange systems without infringing. 1000 w. Elec Engng—Oct. 1, 1897. No. 15786.

Telephone System.

The Smith-Vassar Telephone System. Illustrated description of a new system about to be offered to the public, claiming to afford economical service for local telephony. 800 w. Elec Rev, N. Y.—Oct. 6, 1897. No. 15762.

Wireless Telegraphy.

Telegraphy Without Wires. H. Melville Dowsett. Brief account of a demonstration of "telegraphy without wires," which took place in New Southgate, Eng., under the direction of Signor Marconi. Ill. 1200 w. Elec Eng, Lond—Oct. 1, 1897. No. 15928 A.

MISCELLANY.

Accumulators.

Notes on Accumulator Construction. Desmond G. FitzGerald. Considers how to find the number of plates that a given cell or vessel will contain; and how to find the dimensions of a cell or vessel to contain a given number of plates. 450 w. Elec Eng, Lond—Oct. 1, 1897. No. 15926 A.

Recent Progress in Accumulator Manufacture. (Neuere Fortschritte der Akkumulatorentechnik.) A review of recent progress in storage battery construction, including descriptions of the Pollak, Correns, Gülcher, Linde and Leitner batteries. 5000 w. Glaser's Annalen—Sept. 15, 1897. No. 16187 D.

Storage Batteries. E. J. Wade. From a forthcoming book to be published by *The Electrician* printing and publishing company. Part first discusses the nomenclature, the classification of electrodes, and the material of supports. 2500 w. Elect'n—Sept. 24, 1897. Serial. 1st part. No. 15703 A.

Armatures.

A "Surface-Plate" Balancing Rig. James F. Hobart. Some hints on the accurate mechanical balancing of armatures, with illustration of a testing apparatus. 1000 w. Elec Wld—Oct. 23, 1897. No. 16168.

The Magnetic Field in Tunnel Armatures. F. G. Baily. Discusses the problem of the relation of the mechanical and magnetic forces in conductors buried in a magnetic medium. 1800 w. Elect'n, Lond—Oct. 15, 1897. No. 16142 A.

Batteries.

Thermo-Electric Batteries. C. J. Reed. An explanation of the two general classes of thermo-electric batteries, with illustrated description of types. 1700 w. Elec, Lond—Oct. 15, 1897. Serial. 1st part. No. 16118 A.

Carbon.

Carbon for Electrical Purposes. Facts of interest about the carbon used in the arc lamp and for electrolytic work. 2000 w. Ir & Coal Trds Rev—Oct. 1, 1897. No. 15932 A.

Cells.

Standard Cells. W. C. Fisher. A defense of the Clark cell. 1700 w. Elect'n—Sept. 24, 1897. No. 15701 A.

Clocks.

An Electrical Time-Recording System. Describes a system possessing several features of novelty. A method of automatically operating a number of subsidiary clocks, which may be placed any distance apart from a master timepiece. Ill. 1000 w. Prac Eng—Oct. 8, 1897. No. 16067 A.

Currents.

Effect of Electric Currents on Adjacent Material. James B. Cock. Report of chairman of the special committee of the American Inst. of Architects, given at Detroit, Sept. 29, 1897. Gives theories and investigations made, offering suggestions. 3500 w. In Arch—Oct., 1897. No. 16109 D.

Cut-Outs.

Cut-Outs. Ed. C. de Segundo. Tabulated results from the researches of C. M. Clark and C. W. Macmullen of Columbia University, with comments. 900 w. Elec Rev, Lond—Oct. 1, 1897. No. 15922 A.

Distribution.

Conduits and Cables. Alex. Dow. Describes this practice of the present day with reasons for its adoption, and briefly reviews the earlier conditions. 6000 w. Jour Assn of Eng Soc—Sept., 1897. No. 15989 C.

Fuses.

An Accurate and Reliable Fuse. Louis W. Downes. Describes a method that has been found most successful in eliminating the causes of failure. 3000 w. Am Elect'n—Oct., 1897. No. 15791.

Circuit Breakers and Fuses. F. V. Henshaw. Criticises articles that have appeared on this subject, thinks both have a distinct value under different conditions, but that a fuse can be made to meet all conditions more nearly than a circuit breaker. 1100 w. Am Elect'n—Oct., 1897. No. 15790.

Kirchhoff's Laws.

Kirchhoff's Laws, and Network Calculations. Ellis H. Crapper. Considers, in an elementary manner, Kirchhoff's laws and the methods of applying them. 1300 w. Ind & Ir—Oct. 1, 1897. Serial. 1st part. No. 15933 A.

Lightning.

What We Have Learned About Lightning Since the Time of Franklin. John Trowbridge. Explains the views held by Franklin, and the progress made since, due largely to photography. 2000 w. Chau—Nov. 1897. No. 16225 C.

Microphonograph.

The Perfected Dussaud Microphonograph. (Le Microphonographe Dussaud Perfectionné.) The improved instrument records very feeble sounds, also enables deaf persons to hear clearly the sounds previously impressed upon the recording cylinders. 1200 w. Le Génie Moderne—September 1, 1897. No. 15831 B.

Mold Making.

Porcelain Mold Making. Jacob Henny. Describes a new art arising from the special requirements of the construction of electrical machinery, Ill. 1000 w. Am Mach—Oct. 28, 1897. No. 16201.

Muscular Electricity.

Muscular Electricity. J. Wright. A study of the electrical phenomena attendant on a simple muscular contraction. 1500 w. Elec Rev, Lond—Oct. 15, 1897. Serial. 1st part. No. 16124 A.

Resistances.

The Rating of Resistance Spirals. V. Zingler. Gives an improved method of rating spirals of wire. It no longer becomes necessary to take a certain section of wire for the current, and measure off the ohms required by a bridge. 2000 w. Elec Rev, Lond—Sept. 24, 1897. Serial. 1st part. No. 15705 A.

Rock Drill.

See Civil Engineering, Miscellany.

Self-Induction.

A Method of Measuring the Coefficient of Self-Induction of a Conductor. Lawford H. Fry. Describes a simple method, due to Herr Thiermann, of the Hanover Polytechnikum, which has been used with very good results in the laboratory. 350 w. Elec Rev, Lond—Sept. 24, 1897. No. 15706 A.

Spectra.

Arc Spectra. Arthur L. Foley. Investigations undertaken for the purpose of verifying the results of previous research and of so extending the work as to make it possible to arrive at some more definite conclusion. 7500 w. Phys Rev—Sept., 1897. No. 15794 D.

Testing.

Construction of an Electrical Testing Set. James F. Hobart. Part first gives description and engravings of a measuring instrument constructed by the writer. The making is described. 3000 w. Am Elect'n—Oct., 1897. Serial. 1st part. No. 15793.

MARINE ENGINEERING.

Battleship.

Launch of H. M. S. Canopus. Illustrated description, dimensions, special features and fittings, of one of a new class of battleships, designed by W. H. White. 1800 w. Engr, Lond—Oct. 15, 1897. No. 16136 A.

Beacons.

The United States Light-House Board's New Metal Beacons. Illustrated description of beacons intended for day marks and for survey stations. 1000 w. Eng News—Sept. 30, 1897. No. 15662.

Bulkheads.

Water-tight Bulkheads for Vessels. (Ueber die Wichtigkeit der Wasserdichten Schattwände auf den Schiffen.) An abstract of Middendorf's paper giving the theory and proper practice for the location of bulkheads in vessels. 7000 w. Oesterr Monatschr f d Oeffent Baudienst—September, 1897. No. 15851 D.

Coal Handling.

See Mechanical Engineering, Miscellany.

"Constitution."

The Frigate Constitution. Ira N. Hollis. Reviews the history of this vessel, which is considered to mark the beginning of the United States navy, giving many interesting events connected. 9000 w. Atlantic M—Nov., 1897. No. 16115 C.

The Hundredth Birthday of the Frigate "Constitution." J. D. Jerrold Kelley. Gives an interesting historical account of this famous

American ship. 2200 w. Harpers Wk—Oct. 23, 1897. No. 16078.

Cranes.

Electric Cranes on the Steamship "Bremen." (Schiffskrahne an Bord des Dampfers "Bremen.") An illustrated account of the electrical hoisting plant on one of the North German Lloyd steamers. 1200 w. Glaser's Annalen —September 15, 1897. No. 16189 D.

Diving Bell.

A Diving Bell for Deep Water Wrecking. Description, as given by J. S. Gadsden in the *Inter-Ocean*, of the form of diving bell being used in trying to recover a cargo of copper from the sunken steamer in Lake Huron, near Alpena, Mich. 1200 w. Eng News—Oct. 14, 1897. No. 15968.

Dry Dock.

A Floating Dry-Dock for Havana. Illustrated official description of the dock, with explanation of the essential characteristics of floating docks. 1700 w. Sci Am—Oct. 16, 1897. No. 15950.

Ferry.

The Ferry Steamer Chebucto. Illustrated description of a Canadian double-screw ferry steamer. 700 w. Engr, Lond—Oct. 8, 1897. No. 16029 A.

Fisheries.

Steam Power in the Fishing Business in Europe. Charles Theodore Mason. Information of steamboats used for this business in various countries. 800 w. Sci Am Sup—Oct. 16, 1897. No. 15959.

Gunboat.

Light-Draught Gunboat. Illustrated description of one of the gunboats built for the Egyptian Government. 1900 w. Engng—Oct. 8, 1897. No. 16037 A.

Japanese Navy.

The Coming Sea-Power. Charles H. Cramp. Traces briefly the development of the maritime power of Japan from its foundation, with special attention to her present naval activity, and speculations as to the purpose. 2700 w. N Am Rev—Oct., 1897. No. 15723 D.

Loading Coal.

See Railroad Affairs, Miscellany.

Lost Vessels.

What the Ocean Claims. Interesting data from Lloyd's Register for 1896, especially as related to the United Kingdom. 700 w. Trans —Oct. 8, 1897. No. 16071. A.

Marine Boilers.

See Mechanical Engineering, Boilers.

Merchant Vessels.

Our Need of Merchant Vessels. Alex R. Smith. Editorial Review of an article by Eugene Tyler Chamberlain, in the October Forum, on the United States Merchant Marine, with criticism. 2300 w. Sea—Oct. 7, 1897. No. 15782.

Paddle Steamer.

The Largest and Fastest Paddle Steamer in Great Britain. A. J. Sinclair. An exterior and interior view of the new steel paddle steamer "Empress Queen," with description. 1300 w. Sci Am—Oct. 23, 1897. No. 16080.

Record Breaker.

Transatlantic Record Breaker Kaiser Wilhelm der Grosse. Illustrated description of the fine North German Lloyd liner which recently broke the record of the route from Southampton to New York. 1800 w. Marine Engng—Oct., 1897. No. 15908 C.

Roller Boat.

The Roller Boat Problem. Editorial on the causes of failure in the Bazin boat, and the mistakes in design of the Knapp boat. 1200 w. Sci Am—Oct. 30, 1897. No. 16173.

Stability.

The Various Methods of Determining the Stability of Vessels. (Ueber verschiedene Methoden der Stabilitäts bestimmung von Schiffen.) A very thorough discussion of this important subject by Inspector Schromm, with tables, diagrams and stability curves. Three articles. 15000 w. Zeitschr d Oesterr Ing u Arch Ver—August 27, September 3 & 10, 1897. No. 15826 D.

Shafts.

Tail-end Shafts. Report on the causes of trouble, prepared at the special request of the British Committee of the Bureau Veritas by John Gravell. 1600 w. Mech Wld—Oct. 8, 1897. No. 16053 A.

Shipbuilding.

English and German Shipbuilding. (Englishcher und Deutscher Schiffbau.) A paper by Prof. Oswald Flamm, discussing the growth of British shipbuilding from a German standpoint. 6000 w. Stahl und Eisen—September 1, 1897. No. 15843 D.

Steamship.

Steel Lake-Steamship Starrucca, of Five Thousand Tons Displacement. Illustrated description of the vessel and the launching. 900 w. Marine Engng—Oct., 1897. No. 15910 C.

The "Kaiser Wilhelm der Grosse." Description, with engravings showing the interior decorations. 1600 w. Engng—Oct. 1, 1897. No. 15914 A.

The T. S. S. "Kaiser Friedrich." Brief description of a fine vessel, of the North German Lloyd, recently launched in Dantzig. 1100 w. Engng—Oct. 8, 1897. No. 16040 A.

Steamship Construction.

The Advancement in Steamship Construction. Editorial discussing whether the large proportions and great speed of the Atlantic liners will pay, and the importance of the ship-building industry, its advances and improvements. 2000 w. Am Ship—Oct. 14, 1897. No. 15957.

Steamship Lighting.

See also Electrical Engineering, Lighting.

Stern Wheeler.

Pittsburg and Cincinnati Packet-Line Stern-

Wheel Steamer Queen City. Bert L. Baldwin. A statement of the conditions and requirements of the river service in the Western United States, with illustrated description of the steamer named. 4300 w. Marine Engng—Oct., 1897. Serial. 1st part. No. 15909 C.

Torpedo Boats.

Torpedo Boats in Naval Warfare. Benjamin Micou. Gives the history of torpedo construction, describes their deadly action, calls attention to the small number of these boats owned by the United States, and recommends increasing the number. 3000 w. N Am Rev—Oct., 1897. No. 15720 D.

The Torpedo Boat. A review of the development of this class of war vessels. Considers the essentials to be speed and invisibility. 1400 w. Ir Age—Oct. 28, 1897. No. 16205.

Tugboats.

Dutch-Built Tugboats. Illustrated description of some of the powerful tugboats sailing under the Dutch flag. 4200 w. Steamship—Oct., 1897. No. 15929 A.

Twin Screw.

Twin-Screw Channel Steamer "Roebuck." Illustrated description of two new English channel steamers, giving longitudinal section, deck plans, and photograph of the Roebuck. 1100 w. Engng—Sept. 24, 1896. No. 15685 A.

Yachts.

Small Yachts and Yacht-Racing—1897. W. P. Stephens. New developments indicating a radical change in yachting for the immediate future. Ill. 1800 w. Harper's Wk—Oct. 9, 1897. No. 15716.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

Calorimetry.

Determination of the Calorific Value of Coal with the Mahler Calorimeter and by Jüptner's Formula. (Die Bestimmung des Brennwerthes von Kohlen mittels des Mahler'schen Calorimeters und nach Jüptner's Empirischer Formel.) A review by Baron von Jüptner of the American tests of Messrs. Lord and Haas. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—August 14, 1897. No. 15856 B.

Coal Handling.

Coal and Ash Handling Apparatus. Descriptions with illustrations of the systems in general use. 2500 w. Am Elect'n—Oct., 1897. No. 15789.

Some New Lake Erie Coal-handling Plants. Illustrated description of some of the improved plants located at the beginning of the lake water routes. 1400 w. Eng News—Oct. 7, 1897. No. 15774.

Economy.

Importance of the Boiler. Showing that boilers do not receive the attention they deserve, that they are greatly affected by the surroundings with which each is erected, and that improvements after location often improve the economy. 1300 w. Bos Jour of Com—Oct. 2, 1897. No. 15748.

Efficiency.

The Efficiency of Tube Surface in Locomotive Boilers. (Die Wirksamkeit der Heizrohre in Lokomotiv Kesseln.) A theoretical discussion of this important subject, with valuable experimental data for tubes of various lengths under different conditions. 7500 w. Zeitsch d ver Deutscher Ingenieure—September 18, 1897. No. 15823 D.

Evaporation.

A Theoretical Study of Evaporation in Steam Boilers. (Etude Théorique de la Vaporisation dans les Chaudiéres.) H. Brillé. An analytical and graphical investigation by means of which the evaporation of a given boiler can be computed. Tables and curves are given showing a very close agreement between computed values and the results of actual tests. A valuable article. Three papers. 10000 w. Le Génie Civil—August 21, 28, September 4, 1897. No. 15810 H.

Explosions.

Boiler Explosions in the Year 1896. (Die Dampfkessel- Explosionen während des Jahres 1896.) Tabulating the explosions which occurred in the German empire, with date, location, kind of boiler, and number of persons injured. 1000 w. Glückauf—Sept. 25, 1897. No. 15863 B.

Locomotive Boiler.

A New Water-Tube Locomotive Boiler. Suggestions of Sweney Munson, a locomotive engineer on the Lehigh Valley R. R., with illustrations and dimensions. 700 w. Ry Mas Mech—Oct., 1897. No. 15666.

Marine Boilers.

Note on the Construction of Locomotive Boilers for Vessels. (Ein Beitrag zur Konstruktion der Schiffs- Lokomotivkessel.) Discussing especially details of fire box construction in adapting the locomotive boiler to marine use. 3500 w. Zeitschr d Ver Deutscher Ingenieure—Sept. 11, 1897. No. 15821 D.

Repairs.

How to Make Light Repairs on the Locomotive Boiler. Henry J. Raps. Suggestions and directions for repairing and caring for boilers. 2800 w. Loc Engng—Oct., 1897. No. 15650 C.

Steam Calorimeters.

Apparatus for Determining Moisture in Steam. (Appareils Servant à Mesurer l'Humidité d'une Vapeur.) Describing various calorimeters, including those of Barrus, Carpenter, Gehre, and Rateau. 2500 w. La Revue Technique—Sept. 10, 1897. No. 15881 D.

Steam Condensation.

Some Experiments on the Condensation of Steam. Read before the British Assn. at

Toronto. Part first considers a new apparatus for studying the rate of condensation of steam on a metal surface at different temperatures and pressures, by H. L. Callendar and J. T. Nicolson; and part second explains an electrical method of measuring the temperature of a metal surface on which steam is condensing, by H. L. Callendar. 3300 w. Engng—Oct. 15, 1897. No. 16126 A.

Valves.

Large vs. Small Locomotive Valves. Discusses the results of tests carried out on the Chicago & Northwestern locomotive testing plant for the purpose of showing the comparative values of small and large ports on the proportion of the mean effective pressure to the boiler pressure. 1000 w. Am Eng & R R Jour—Oct., 1897. No. 15654 C.

Watertube Boilers.

The Buttner Multitubular Boiler. (Chaudières Multitubulaires Système Buttner.) A combined system of shell and water-tube boiler, intended to unite good steaming qualities with large reserve capacity. 1200 w. La Revue Technique—Sept. 10, 1897. No. 15878 D.

Tests of Water-tube Boilers in the German Navy. (Versuche in der Deutschen Kriegsmarine mit Wasserrohrkesseln.) Giving results of tests of a variety of boilers made at Stettin during the past year including the Thorneycroft, Dürr, Belleville and Niclausse types. Two articles, 3000 w. Zeitschr d Ver Deutscher Ingenieure—Sept. 11 and 18, 1897. No. 15824 G.

COMPRESSED AIR.

Motors.

Reports of Experience with Compressed Air Motors on Elevated and Street Railways. Papers bearing on the economical results obtained with compressed air motors on street railways. A statement from Hermann Haupt, and reports of engineers employed by the Commissioners of the Dist. of Columbia, U. S. A., to examine the system of traction which should be adopted in Washington. Also editorial. 12000 w. Eng News—Oct. 7, 1897. No. 15772.

Postal Tubes.

The Pneumatic Postal Tube, New York. Reviews briefly the history of transportation through closed tubes and gives description, with illustrations, of the pneumatic tube service in process of construction in this city. 3000 w. Eng Rec—Oct. 23, 1897. No. 16127.

Signals.

The Thomas Pneumatic System of Handling Railway Switches and Signals. Illustrated detailed description. The fundamental feature is the manipulation of the valves admitting air to and exhausting it from the working cylinders, by means of pistons of the equalizing type. Ill. 4000 w. Compressed Air—Oct., 1897. No. 16101.

Test.

Test of a Four-Stage Air Compressor at Pressures Up to 2500 lbs. per sq. in. K. E. Stuart and H. L. Terwilliger. Condensed from a graduating thesis at Cornell University, Ithaca, N. Y. Describes plant, plan and theory of test, the testing, and gives conclusions. 4800 w. Eng News—Oct. 7, 1897. No. 15773.

ENGINES AND MOTORS.

Blowing Engine.

Compound Beam Blowing Engine in the Silver and Lead Works at Pribram. (Ueber die Balancier Compound Gebläsemaschine bei der Silber und Bleihütte zu Pribram.) A double beam engine of 75 horse power of good design, with Corliss valve gear. Two articles, 1 plate, 7500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Sept. 18, 25, 1897. No. 15861 E.

Engines.

See Electrical Engineering, Lighting. See also Street and Electric Railways.

Engine Trials.

Trials of a Horizontal Compound Tandem Engine. From Mr. Longridge's report to the Engine, Boiler, and Employers' Liability Assn., 1896. Describes the engine and boiler, giving the measurement of feed water and indicator diagrams, with remarks upon the trials. 1800 w. Prac Eng—Oct. 15, 1897. No. 16152 A.

Fuel.

Petroleum Steam-Engine Fuel. J. A. F. Aspinall. Read before the Institution of Civil Engineers (England). Reviews the experiments that have been made and the methods of applying the oil, pronouncing it an ideal method of raising steam, the only difficulty being the cost. 1300 w. Am Eng & R R Jour—Oct., 1897. No. 15655 C.

Heat Motors.

A Discussion of Heat Motor Cycles. (Die Beurteilung der Kreisprozesse von Wärmekraftmaschinen.) An examination of the Carnot cycle by Prof. Meyer, with especial reference to the Diesel heat motor. 8000 w. Zeitsch d Ver Deutscher Ingenieure—Sept. 25, 1897. No. 15824 D.

High Speed.

The Raworth Universal Steam Engine. (Machine à Vapeur Universelle, Système Raworth.) With illustrations of details, and some account of the Raworth high-speed engine as shown at the Brussels Exposition, and installed at Vincennes and at Wandsworth, England. 3500 w. 1 plate. La Revue Technique—October 10, 1897. No. 15597 D.

Mill Engine.

Coupled-Compound Horizontal Mill Engine. Illustrated description of a condensing engine recently erected for driving the large flour mills, known as the "steam mills," in Wolverhampton, England. 800 w. Engr, Lond—Oct 1, 1897. No. 15921 A.

Oil Engine.

The "Diesel" Oil Engine. Illustrated description of the invention of Rudolph Diesel, called a "Rational Heat Motor," as given in the *Zeitschrift des Vereines deutcher Ingenieure*. The summarized translation is by B. Donkin. 4500 w. Engr, Lond—Oct. 15, 1897. No. 16135 A.

Petroleum Motor.

Petroleum Motor for Tricycles. (Moteur à Pétrole pour Tricycle.) The Dion Bouton & Co. motor is operated with vaporized petroleum, on the Otto cycle, with electric ignition. The speed is controlled by varying the air admission. 1500 w. La Revue Technique—Sept. 25, 1897. No. 15583 D.

The New Otto Petroleum Motor. (Nouveau Moteur à Pétrole "Otto.") The principal novelty lies in the valve gear, which is operated by an eccentric, giving much less noise than a gear and cam motion. The petroleum is used as a spray, with tube ignition and the usual Otto cycle. Serial. Part I. 2500 w. Le Génie Moderne—October 15, 1897. No. 16180 B.

Pumping Engine.

See Municipal Engineering, Water Supply.

Regulation.

The Economical Governing of Steam Engines. John S. Raworth. Comparing the relative methods of governing by throttling and by varying cut-off. Willans law is discussed and curves of steam consumption per horse power given for various conditions of load and regulation. 2500 w. Engineering Magazine—Nov., 1897. No. 15593 B.

Testing.

Testing Engines. A consideration of the practical points. 2200 w. Bos Jour of Com—Oct. 16, 1897. No. 16020.

POWER AND TRANSMISSION.

Elevator Accident.

Lessons of the Elevator Accident in the Tract Building, New York City. Editorial comment on the verdict of the coroner's jury and discussion of the cause. 1500 w. Eng News—Sept. 30, 1897. No. 15660.

Water Power.

The Water-Power Resources of the State of Washington. Eleazer Darrow. Illustrated account of some of the undeveloped water powers in this State. 1500 w. Elec Wld—Oct 23, 1897. No. 16167.

SHOP AND FOUNDRY.

Bearings.

Prevention of the Sliding Friction of Ball and Roller Bearings. From *La Nature*. Illustrated description of the invention of B. M. G. Philippe for obviating the sliding friction of rollers. 800 w. Sci Am Sup—Oct. 16, 1897. No. 15958.

Belgium.

A Belgian Engine-Shop. F. J. M. An account of the establishment of H. Bollinckx, of Brussels, Belgium. Ill. 1100 w. Am Mach—Oct. 14, 1897. No. 16001.

Bell Founders.

Bell Founders in England. Interesting information of this industry which dates from mediæval times. 1400 w. Mach, Lond—Oct. 15, 1897. No. 16156 A

Boiler Tools.

Staking and Riveting Tools. A. H. Cleaves. Illustrated description. 500 w. Am Mach—Oct 21, 1897. No. 16097.

Boring Mill.

A Boring-Mill Job as a Trade Secret—Some "Practical" Mathematics. A question regarding the turning of a steel casting is answered, showing it to be a matter of simple mathematics and not a "trade secret." 1100 w. Am Mach—Oct. 7, 1897. No. 15760.

Cost-Keeping.

Cost-Keeping Methods in Machine Shop and Foundry. Henry Roland. The details of several large shops are compared, especially with respect to piece-work rates and the different forms of piece-rate tickets, blanks and records. Forms of order blanks in practical use are given and discussed. 6000 w. Engineering Magazine—Nov., 1897. No. 15590 B.

Crank Pins.

Improved Lubrication of Crank Pins. E. O. Hefford. Brief illustrated description of a device found to give excellent results in practice. 500 w. Prac Eng—Oct. 1, 1897. No. 15935 A.

Electric Driving.

Electricity versus Shafting in the Machine Shop. Charles H. Benjamin. Showing the economic advantages of electricity. 5000 w. Am Gas Lgt Jour—Oct. 4, 1897. No. 15735.

Exposition.

Machinery at the Universal Exposition of 1900. (Les Machines à l'Exposition Universelle de 1900.) B. de Priène. A discussion of recent progress in machine tool design, urging a full exhibit of French tools at Paris in 1900. 2000 w. La Revue Technique—October 10, 1897. No. 16179 D.

Forge.

Researches upon Forge Fires with Water Spray Blast. (Versuche mit Schmiedefeuern und das Wasserstaubfeuer von Bechem & Post.) Showing the higher efficiency gained by introducing moisture into the blast, with description of the apparatus. 3500 w. Stahl und Eisen—September 15, 1897. No. 15847 D.

Foundry Metals.

Comparative Fusibility of Foundry Metals. Thomas D. West. Read at the Cincinnati meeting of the Western Foundrymen's Assn. Gives tabulated results obtained by the writer and discusses them, and shows the economy and advantages to be obtained by using chilled pig metal in foundries and in Bessemer-steel works. 2000 w. Am Mfr & Ir Wld—Oct. 22, 1897. Serial. 1st part. No. 16147.

Gear Cutter.

A Large Gear Cutter. Describes a gear-cutting machine of unusual size, which has recently been added to the equipment of the Newton Machine Tool Works. 500 w. Am Mach—Oct. 21, 1897. No. 16099.

Grinder.

A New Drill Grinder, Illustrated description of an improved machine invented by O. S.

Walker. 1300 w. Am Mach—Oct. 28, 1897. No 16202.

Hydraulic Press.

Hydraulic Press of 350 Tons Capacity. (Presse Hydraulique de 350,000 Kilogrammes.) A powerful press for hydraulic forging, on the Tenner system, with steam accumulator. 1500 w. La Revue Technique—Sept. 10, 1897. No. 15582 D.

Inspectors.

Instructions to Inspectors at Mills and Shops. J. A. L. Waddell. Twenty suggestions to aid the work of inspectors. 1000 w. Ind Engng —Sept. 18, 1897. No. 16110 D.

Laps.

Laps. Explains the usefulness of these tools and the advantage of having a set in the average shop, giving illustrations of the work. 3500 w. Am Mach—Oct. 7, 1897. No. 15759.

Lathes.

Alignment of Engine Lathes. S. Ashton Hand. The object of the article is to show how lathes should be aligned in the process of building and also to enable owners of lathes to test them properly for accuracy. Ill. 900 w. Mach, N Y—Oct., 1897. No. 15745.

Machine Tools.

Machine Tools from Another Point of View. J. W. Gardner. Reference is made to a paper presented by William Forsythe on this subject, and a discussion of the way to get any reliable information of the efficiency of machine tools, with statement of the conditions existing in railroad shops. 1800 w. Ry Mas Mech—Oct., 1897. No. 15667.

Molding Machinery.

A Modern Foundry. An account of a visit to the Worthington foundry at Elizabethport, N. J., describing the work, and calling attention to the general use of the molding machine. 2000 w. Am Mach—Oct. 7, 1897. No. 15761.

Molding Sand.

Molding Sand. D. H. Truesdale. Read at the Cincinnati meeting of the Western Foundrymen's Assn. Discusses the necessary elements of molding sand and the proportions needed in combination. Considers refractory qualities, porosity, fineness and a sufficient bond. 1200 w. Am Mfr & Ir Wld—Oct. 22, 1897. No. 16148.

Physical Tests.

The Value of Physical Tests. S. S. Knight. Read before the Western Foundrymen's Assn. at Cincinnati. Discusses this subject and concludes that physical tests will be found valuable only as they are made on reliable apparatus, and that no system of testing will equal the ingenuity of a trained and competent man, with facilities to use his knowledge. 3000 w. Ir Age—Oct. 21, 1897. No. 16076.

Planing Machine.

A Large Post-Planing Machine. Illustrated description of a machine made by Bement, Miles & Co., for the Bethlehem Iron Works. 700 w. Am Mach—Oct, 21, 1897. No. 16098.

Rubber Factory.

The Works of the Peerless Rubber Manufacturing Company, New Durham, New Jersey. Illustrated description of the process as practiced by this company. 3000 w. Am Eng & R R Jour—Oct., 1897. No. 15651 C.

Springs.

Cylindrical Spiral Springs. George. R. Bale. Diagrams, giving dimensions of cylindrical spiral springs for given loads, limiting the stress on the material to 16-tons per square inch, with explanations. 1300 w. Mech Wld—Oct. 8, 1897. No. 16052 A.

Steel Tubing.

The Steel Pipe and Tube Industry. Illustrated detailed description of the work as carried on by the National Tube Works Co. 2500 w. Sci Am—Oct. 23, 1897. Serial. 1st part. No. 16081.

Tubes.

The Manufacture of Iron Boiler Tubes. (Fabrication des Tubes à Fumée en Fer.) Describing the Boulet system of making lap welded boiler tubes, with illustrations of the machines and description of the methods of testing the finished product. 3000 w. Le Génie Civil—Sept. 11, 1897. No. 15816 D.

Turret Lathe.

The Home of the Flat Turret Lathe. Illustrated description of the shops and work of the Lamson Machine Company, at Springfield, Vt. 2000 w. Mach, N Y—Oct., 1897. No. 15746.

Vents.

Lighting Vents in the Foundry. R. Watson, in *Iron Moulders' Journal.* Considers the general practice a mistake and gives reasons. 1000 w. Prac Eng—Oct. 8, 1897. No. 16068 A.

MISCELLANY.

Automobiles.

Methods of Obtaining Motive Power for Motor Carriages. A free translation of an article by Marcel Deprez, from *Génie Civil.* Gives statement compiled by M. Barbet on the Mékarsky system, discusses the use of liquified gases, of hot-water under pressure, &c. 2000 w. Automotor—Oct., 1897. No. 16154 A.

The "Heavy Weights" Competition of the Automobile Club. From *La Nature.* An account of the international competition which recently took place in Paris, with illustrations of the principal types of the vehicles that competed. 1300 w. Sci Am Sup—Oct. 9, 1897. No. 15769.

Belts.

A New Formula for Determining the Width of Leather Belting. John J. Flather. Presented before Sec. D, Am. Assn. for the Advancement of Science, Detroit. Gives formula with additional information. 2200 w. Am Mach—Oct. 28, 1897. No. 16204.

Balloon.

The Aeronautic Expedition of M. Andrée to the North Pole. (L'Expedition Aeronautique de M. Andrée au Pôle Nord.) With photographic views of the buildings, gas generators

and apparatus pertaining to the protection and inflation of the balloon. 2500 w. Le Génie Civil—Aug. 21, 1897. No. 15809 D.

Bicycles.

The Chainless Bicycle. Report of the efficiency tests by Professor Denton, made for the Pope Manufacturing Co., giving detailed data, method, description, &c., with general conclusions. 4500 w. Ir Age—Oct. 21, 1897. No. 16075.

The Columbia Chainless Bicycle. Illustrated description of the mechanical details of the driving gear, and of the machine which has been designed for cutting the epicycloidal teeth of the bevel gears. 1200 w. Sci Am—Oct. 30, 1897. No. 16174.

The Columbia Chainless. Russell Stone. Illustrated description and the history of the invention. 4500 w. McClure's Mag—Nov., 1897. No. 16226.

Compression Tests.

The Resistance of Bars to Compressive Forces. (Résistance des Barres Soumises à des Efforts de Compression.) M. Dupuy. A record and discussion of a large number of official tests of steel bars, with tables and diagrams. The Klein Elasticimeter was used. 25000 w. Two plates. Ann Des Ponts et Chaussées—Pt. I, 1897. No. 15867 F+G.

Elevator Accident.

Elevator Accident in a New York Hotel. Brief account of the falling of an elevator in Hotel Waldorf which injured two employee and badly damaged the car. 400 w. Eng Rec—Oct. 16, 1897. No. 16056.

Engineering.

The Engineering Industry in the States. Compares American workmanship and methods with the English, showing the disadvantages under which the latter labor, and the benefits in the United States from labor-saving machinery. 1500 w. Mach, Lond—Oct. 15, 1897. No. 16157 A.

Galvanizing.

On an Improvement in the Art of Galvanizing. George C. Reese. The object of the paper is to call attention to a recent advance in the art of galvanizing, by which many objectionable features are obviated, insuring greater rapidity, better quality, economy, and resulting in new forms of coated material. Ill. 2000 w. Jour Fr Inst—Oct., 1897. No. 15779 D.

Graphics.

The Use of the Graphical Method in Experimental Science (La Methode Graphique et les Sciences Expérimentales.) Portion of an address by M. Marey upon the value of mechanically recording devices in experimental investigations. 1500 w. Le Génie Moderne—Sept. 15, 1897. No. 15832 B.

High Temperatures.

Some Modern Devices for Securing High Temperatures. W. H. Birchmore. A résumé of the variety of appliances used for this purpose, as seen and studied by the writer. 5000 w. Am Gas Light Jour—Oct. 4, 1897. No. 15734.

Lubrication.

Lubrication. George L. Fowler. A few suggestions as to the considerations that should have weight in making a selection of lubricants and bearing metals to be used on cars. 3800 w. Ry Mag—Sept., 1897. No. 16160 C.

Roller Bearings.

See Railroad Affairs, Maintenance of Equipment.

Rotation.

Some Phenomena of High-Speed Rotation. James F. McElroy. Abstract of a paper read before the Albany Institute. Illustrated description of phenomena observed while engaged in the development of a steam turbine running at very high speeds. 1700 w. Elec Wld—Oct. 16, 1897. No. 16050.

Speed Indicator.

Electro-Magnetic Speed Indicators. (Les Tachymètres Electro-Magnetiques.) The Abdank-Abankowicz speed indicator acts by the angular displacement of a metallic disk by a revolving magnet. 1500 w. La Revue Technique—Sept. 10, 1897. No. 15880 D.

Testing.

International Association for Testing Materials of Construction. (Internationaler Verband für die Materialprüfung der Technik.) A report of the meeting of the International Association held at Stockholm in August, with discussion of papers. 8000 w. Stahl und Eisen—Sept., 15, 1897. No. 15848 D.

The Influence of Testing upon the Resistance to Bending at Lower Temperatures. (Einfluss des Prüfungs verfahrens auf das Ergebniss der Biegeproben bei niederen Wärmegraden.) A review of Prof. Rudeloff's tests at the Charlottenburg laboratory. Both bending and drop tests were made. 4500 w. Stahl und Eisen—Sept. 1, 1897. No. 15844 D.

The Results of Tests for Rupture. (Ueber Ergebnisse von Zerreiss versuchen.) A discussion by Herr Knaudt, of some elongation and rupture tests made at the Charlottenburg laboratory, with a rejoinder by Prof. Martens. 3000 w. Zeitschr d Ver Deutscher Ingenieure—Sept. 25, 1897. No. 15825 D.

Tool Grinding.

Systematic Tool-Grinding. Illustrated description of method observed in a shop in Leipzig, Germany. 1000 w. Am Mach—Oct. 28 1897. No. 16203.

Tools.

Machine Tools. Editorial on the development of the automatic tool in England, sure to follow the present dispute in the engineering trade. 1300 w. Engr, Lond—Oct. 8, 1897. No. 16031 A.

Type Setting.

Machine Substitutes for the Composition of Types by Hand. Harold M. Duncan. Deals with the machines which have reached commercial stages, from the standpoint of principles. Considers the operations and requirements of good printing. Ill. 11000 w. Jour Fr Inst—Oct., 1897. No. 15778 D.

MINING AND METALLURGY.

COAL AND COKE.

Anthracite.

The Competition Against Anthracite Coal. From the monthly letter of the Anthracite Coal Operators' Assn. A statement of the conditions of to-day and their effect on the anthracite coal trade. 2300 w. Ir Age—Oct. 14, 1897. No. 15956.

Briquettes.

Briquettes and Briquette Machinery. Philip R. Björling. Describes the making of briquettes and the various binding materials used, naming the qualities they should possess, and the mechanical processes through which the material must pass. Ill. 3500 w. Col Guard—Sept. 24, 1897. Serial. 1st part. No. 15693 A.

Cannel.

An Austrian Cannel Seam. R. Danilof, in *Oesterreichische Zeitschrift für Berg-und Hüttenwesen.* An account of the location, thickness, quality, &c. 900 w. Col Guard—Sept. 24, 1897. No. 15697 A.

Coal Analysis.

Ultimate Analysis of Coal. F. Haber and S. Grinberg, in *Zeitschrift für Analytische-Chemie.* Describes the method of analysis which has been used for some time at the experimental stations at Munich and Karlsruhe. 1300 w. Col. Guard—Oct. 15, 1897. No. 16131 A.

Coal Ash.

The Relation between Composition and Fusibility in Coal Ash. Report of investigations made. 1500 w. Col Guard—Oct. 1, 1897. No. 15916 A.

Coal Formation.

The Manner of Coal Formation. G. Schmitz. From a communication to the *Revue des Questions Scientifiques.* Presents the arguments of M. F. Rigaud in proof of coal being an eruptive rock and the difficulties in connection with the theory. 1700 w. Col Guard—Oct. 1, 1897. No. 15915 A.

Coal Measures.

Belgian Coal Measure Museum. From a brochure issued, in connection with the Brussels International Exhibition, by G. Schmitz. Information of the coal formation, and stating the object of the museum, and the arrangement of the specimens. 3000 w. Col Guard— Oct. 15, 1897. No. 16132 A.

The Permo-Carboniferous Boundary. C. E. De Rance. Read before the Manchester Geological Society. A study of the coal measures in England. 4800 w. Col Guard—Oct. 1, 1897. No. 15917 A.

Coal Statistics.

The Production, Value and Distribution of Coal in 1896. Tabulated statements and discussion of the coal industry of the United Kingdom. 1500 w. Col Guard—Sept. 24, 1897. No. 15694 A.

Coal Trade.

See same title under Economics and Industry, Commerce and Trade.

Faults.

A Peculiar Formation. George W. Engel. A description of a peculiar fault in the Mammoth coal bed, Panther Creek Basin, Pennsylvania. 700 w. Col Eng—Oct., 1897. No. 16012 C.

France.

Colliery Development in the North of France. F. Colomber, in *La Revue Technique.* Describes the sinking of a new shaft in the Pas-de-Calais district, which has greatly increased the output, and the development of the working area. 1500 w. Col Guard—Oct. 8, 1897. No. 16032 A.

Mechanical Installations.

Underground Mechanical Installations at a Belgian Colliery. Edm. Briart. Describes and illustrates the installations made at St. Catherine Pit of the Bascoup Colliery, in Belgium. 2000 w. Col Guard—Sept. 24, 1897. No. 15698 A.

Nova Scotia.

Analysis of Nova Scotia Coals and other minerals. E. Gilpin, Jr., Gives analysis made by J. T. Donald, taken from the workings at a depth of 800 to 1000 feet. Compares them with analysis made by the writer about 1880, and briefly considers iron and other ores. 1000 w. Can Eng—Oct., 1897. No. 15982.

Ownership.

Reputed Ownership as Regards Colliery Machinery, Plants and Coal. Cases decided by the English superior courts bearing upon the bankruptcy law. 1600 w. Col Guard—Oct. 8, 1897. No. 16033 A.

Safety Lamps.

Thermo-Electric Magnetism and Mining Safety-Lamps. Describes a singular case of thermo electric magnetism in a safety-lamp, and the investigations of the cause. 2500 w. Col Guard—Sept. 24, 1897. No. 15695 A.

South Africa.

The South Rand Coalfield. A. R. Sawyer. Extract from a paper read before the Federated Inst. of Mining Engs. Describes this portion of the South African formation, which the writer explored personally and in which he discovered a very valuable coal-seam. 2400 w. Col Guard—Sept. 24, 1897. No. 15700 A.

South Russia.

The South Russian Iron and Coal Industries. Professor Thimé. Translated by G. Kamensky. Information of coal mines and iron works gathered on a recent journey, and intended to illustrate the actual condition of these industries in the region named. 3200 w. Col Guard—Oct. 15, 1897. Serial. 1st part. No. 16130 A.

Subsidence.

Subsidence Caused by the Workings in Mines. W. Galloway. Read before the South Wales Institute of Engineers. Gives views and observations relating to this subject by eminent engineers, considering also certain phenomena which help to an understanding of the subject. 4200 w. Col Guard—Sept. 24, 1897. Serial. 1st part. No. 15696 A.

Thin Seams.

The Working of Thin Horizontal Seams in England. (Abbau Minder Mächtiger, Flachliegender Flötze in England.) Hans Gutmann, Describing the "board and pillar," and "long wall" systems of coal mining as seen by a German engineer. Two articles, 1 plate. 7500 w. Oesterr Zeitschr f Berg u Hüttenwesen—September 4, 11, 1897. No. 15859 E.

Winding.

Winding from Great Depths with Constantly Balanced Ropes. André Després. Describes the means for practically carrying out this system, giving illustrations. 2800 w. Col Guard—Sept. 24, 1897. No. 15692 A.

COPPER.

Lake Superior.

Atlantic Copper Mine, Houghton County, Michigan. Theodore Dengler. Read before the Denver Society of Civil Engs. General information of the copper mines of the Lake Superior region with special consideration of the Atlantic Mine. 2500 w. Jour Asso of Eng Soc—Sept., 1897. No. 15994 C.

GOLD AND SILVER.

Alabama.

Some Auriferous Quartz Bodies in Alabama, W. M. Brewer. Describes the occurrences of gold-bearing ores in Alabama, with suggestions and general information. 1400 w. Eng & Min Jour—Oct. 16, 1897. No. 15999.

Appalachian.

The Southwestern Extremity of the Appalachian Gold-Fields. William B. Phillips. Thinks there is but little hope of the placers of this part of the United States and that money spent should be devoted to the quartz seams. 1500 w. Eng & Min Jour—Oct. 2, 1897. No. 15679.

Cyanid.

Cyanid Solutions for Leaching Auriferous Ores and Tailings. Walter J. Studds. Describes the solution as applied on the Coolgardie goldfields. 1000 w. Aust Min Stand—Sept. 16, 1897. No. 16171 B.

Notes on the Action of Potassium Zinc Cyanid Solutions on Gold. W. J. Sharwood. The views of various writers as to the nature of the chemical changes taking place during solution are reviewed in part first. 1200 w. Eng & Min Jour—Oct. 2, 1897. Serial. 1st part. No. 15678.

Dredging.

Placer-Mining Dredges on Grasshopper Creek, Montana. Illustrated description of the ladder dredge used for this work. 1000 w. Eng News—Oct. 14, 1897. No. 15970.

Georgia.

Gold Mining in Georgia. F. H. Richardson. An account of the extent of the operations in progress and projected. 2000 w. Mfrs Rec—Oct. 15, 1897. No. 16016.

Golden Age.

Gold: The Coming Golden Age. Almarin B. Paul. Extracts from an address before the California Pioneer Assn. Presents the history of the increase in volume of the world's gold since its discovery in California, with reasons and expectations for the future. 1400 w. Min & Sci Pr—Oct. 23, 1897. No. 16206.

Gold Dredger.

The Ball Gold Dredger. Describes a combination dredger and gold saver in use in South Africa and in Madagascar. 2300 w. Engr, Lond—Oct. 8, 1897. No. 16027 A.

Gold Tax.

Gold Export Tax in Nicaragua. Consular report of a decree establishing an export duty of $1 (gold) per ounce on gold ingots and $2 (gold) per ounce on gold dust. 900 w. Cons Repts—Oct. 23, 1897. No. 16153 D.

Klondike.

Placer Mining in the Klondike Country. Brief description of the region and the methods of working. 1000 w. Eng & Min Jour—Oct. 9, 1897. No. 15907.

The Klondike Gold-Fields. H. Bratnober. A description of the placers, and the conditions found, by one who has just returned from Alaska. 1200 w. Eng & Min Jour—Oct. 23, 1897. No. 16111.

Manchuria.

The Gold Deposits of Manchuria. M. Réné de Batz in the *Génie Civil*. Some particulars with regard to these deposits, with map showing proposed Eastern Chinese railroad. 1500 w. Eng & Min Jour—Oct. 16, 1897. No. 15998.

Ontario.

The Gold-Fields of the Rainy River District. Horace V. Winchell. Comments on the salient features of the Rainy-Lake and Seine river portions of this large district in Western Ontario. Map. 2800 w. Eng & Min Jour—Oct 23, 1897. No. 16112.

Russia.

The Gold Mines of the Russian Empire. (Les Mines d'or de l'Empire Russe.) An illustrated account of the gold mines of the Ural and of Siberia, with statistics, methods of working and prospects with the introduction of railways. Two articles, 1 plate. 6000 w. Le Génie Civil—July 24, Aug. 7, 1897. No. 15800 G.

San Juan.

The Needles. Arthur Lakes. A report of a recent exploring excursion to the Needles region of the San Juan in Colorado. A description of the peculiar formations and appearance of the country and some suggestions in regard to its possibilities as an ore-producing region. Ill. 2200 w. Col Eng—Oct., 1897. No. 16013 C.

Tasmania.

The Lefroy Goldfields, Tasmania. Leslie Jolly. A descriptive paper, based on absolute facts that have come within the knowledge of the writer. 2400 w. Aust Min Stand—Sept. 9, 1897. No. 16026 B.

Veins.

Vein Occurrence. Arthur Lakes. A study of vein formation as illustrated in Clear Creek cañon, Colorado. Ill. 1200 w. Col Eng—Oct., 1897. No. 16014 C.

IRON AND STEEL.

Armor Plates.

The Attack of Harveyed Armor-Plates by Armor-Piercing Projectiles. A table giving results obtained against treated armor of the highest class, with discussion of the same. 1500 w. Engr, Lond—Oct. 15, 1897. No. 16134 A.

The Witkowitz Armor-Plate Tests. (Tir d'Essai contre des Plaques de Blindage à l'Usine de Witkowitz.) A full account of the Austrian armor-plate tests, with photographs of the action of projectiles upon steel plates, Harveyized and non-Harveyized, also plates of nickel steel. 3000 w. La Revue Technique—October 10, 1897. No. 16177 D.

Blast Furnace.

The "Kraft" Iron Works. (Das Eisenwerk "Kraft.") Illustrated description of these new works at Kratzniek, near Stettin, on the Oder, with plate of blast furnace details. 3500 w. Stahl und Eisen—September 1, 1897. No. 15841 D.

Cooling.

The Influence of Sudden Cooling on Nearly Pure Iron. Albert Sauveur. A reply to paper by J. O. Arnold on the same subject. 1000 w. Eng & Min Jour—Oct. 23, 1897. No. 16113.

Edison Mines.

Edison Ore Mines. An interview with Mr. Edison with a description of works and processes. 3000 w. Elec Rev, N Y—Oct. 27, 1897. Also Ir Age—Oct. 28, 1897. No. 16200.

Edison's Revolution in Iron Mining. Theodore Waters. Illustrated description of the new application of electricity. 8500 w. McClure's Mag—Nov., 1897. No. 16227.

Microscopy.

The Microscopic Inspection of Steel. Francis Scott Rice. Notes of experience in the microscopic examination of steel. Ill. 1700 w. Eng News—Oct. 28, 1897. No. 16207.

Nickel Steel.

Nickel Steel. C. E. Guillaume. Translated from *Comptes Rendus*. A study of these alloys, giving results. 700 w. Am Mfr & Ir Wld—Oct. 15, 1897. No. 16022.

Open Hearth.

Charging Devices for Open Hearth Furnaces. (Beschickungsvorrichtungen für Martinöfen) Principally illustrating the Wellman electric charging machine as used in Germany, with photographs of the device at the Lauchhammer Works. 5000 w. Stahl und Eisen—September 1, 1897. No. 15842 D.

Ore Loading.

Iron Ore Loading on the American Great Lakes. H. J. Slifer. With illustrations of the apparatus and harbor facilities by means of which about ten million tons of iron ore are handled in a season, in the Lake Superior region. With maps of the Gogebic Iron Region. 3000 w. Engineering Magazine—Nov. 1897. No. 15595 B.

Production.

Iron Ore and Pig Iron Production in 1896. Report of the United Kingdom compiled from the *Mineral Statistics*. 2000 w. Col Guard—Oct. 1, 1897. No. 15918 A.

Southern Mines.

Southern Iron Mining. William M. Brewer. A description of the iron ore mines of Alabama and Georgia. The methods of mining red hematite and brown limonite and manganese ores and the different processes of washing and preparing them for the furnace. Ill. 4000 w. Col Eng—Oct., 1897. No. 16011 C.

South Russia.

See also Coal and Coke.

Steel Tubing.

See same title under Mechanical Engineering, Shop and Foundry.

Sweden.

A Review of the Development of the Iron Industry in Sweden. (Einige Hauptzüge der Entwicklung der Eisenindustrie in Schweden.) A paper presented by Axel Whalberg before the international congress for testing materials at Stockholm. 2500 w. Stahl und Eisen—September 1, 1897. No. 15845 D.

Thermo-Chemistry.

A Preliminary Thermo-Chemical Study of Iron and Steel. E. D. Campbell and Firman Thompson. A paper presented to the American Chemical Society. Describes work undertaken to determine whether carbon alone was responsible for the variations in the heat of solution of steel subjected to different heat treatments. 3300 w. Ind & Ir—Oct. 1, 1897. No. 15934 A.

Vickers' Works.

Vickers' Works at Sheffield, England. Historical account and illustrated detailed description. 3800 w. Engng—Oct. 1, 1897. Serial. 1st part. No. 15912 A.

MINING.

Accidents.

The Fatal Accidents in the Prussian Mines in 1896. (Verunglückungen mit Tödtlichem Ausgange beim Bergwerksbetriebe Preussens während des Jahres 1896.) With tabulated results from 1891 to 1896, and a general review of the nature and causes of the disasters. 2000 w. Glückauf—September 25, 1897. No. 15865 B.

Aluminum.

Processes in the Metallurgy of Aluminum Developed in 1897. (Procédes Mis en Oeuvre en 1897 dans la Métallurgie de l'Aluminum.) Alfred Boudon. The first of a series describing the most recent advances in the isolation of al-

uminum, as well as some new alloys. Serial, Part I. 3000 w. La Revue Technique—October 10, 1897, No. 15598 D.

Cobalt.

The Cobalt Deposits in the Westerwald. (Das Kobalt-Vorkommen in Westerwalde.) Giving an account of the manganiferous cobalt deposits in Rhenish Russia, and suggesting possible uses of the metal and its compounds. 2500 w. Glückauf—October 2, 1897. No. 15866 B.

Creeps.

The Control of Creeps. Edward Jones. Methods of working coal seams in Northern Illinois which control creeps and avoid crushes. Describes some of the requirements for a successful system, and the precautions necessary in laying out and carrying on the work. Ill. 2000 w. Col Eng—Oct., 1897. No. 16015 C.

Locomotive.

New Compressed Air Mining Locomotive. Illustration, with brief description of an air motor made by the Dickson Manufacturing Co., for the D. & H. Canal Co. 750 w. R R Gaz—Oct. 29, 1897. No. 16218.

Lead Smelting.

The Application of Tin Plate Scrap in Lead Smelting. (Verwerthung von Weissblechabfällen in Bleihüttenbetriebe.) A paper by Dr. August Harpf describing his process for using tin plate cuttings in the reduction of lead. Two articles. 6000 w. Oesterr Zeitschr f Berg u Hüttenwesen—August 14, 21, 1897. No. 15858 E.

Measurements.

Survey Measurements of Steep Drivages. Joh. Nemecek, in *Oesterreichische Zeitschrift für Berg-und Hüttenwesen.* Illustrated description of methods suggested. 900 w. Col Guard—Sept. 24, 1897. No. 15691 A.

Methane.

The Determination of Methane in Mine Gases. (Uber die Bestimmung des Methans in der Grubenluft.) E. Hankus. Showing the variation in the percentage of Methane for different barometric pressures, and giving the results of analyses. 800 w. Oesterr Zeitschr f Berg u Hüttenwesen—October 2, 1897. No. 15862 B.

Mexico.

The Operation of a Mexican Mine. (Einrichtungen einer Mexicanischen Erzgrube.) Descriptive account of a visit to a typical Mexican mine in the Sierra Madre. 3500 w. Glückauf—September 11, 1897. No. 15853 B.

Quarrying.

Some Modern Appliances for Quarrying and Manipulating Stone. William L. Clements. Considers the conditions reached in the advancement of this work, by the introduction of new machinery. Ill. 3500 w. Stone—Oct., 1897. No. 16102 C.

Quicksilver.

The St. Anna Quicksilver Mine and Works in Krain. (Das Quecksilber Berg- und Hüttenwerk zu St. Anna in Oberkrain.) Describing the successful reopening and extension of these old abandoned workings. Two articles. 5000 w. Oesterr Zeitschr f Berg u Hüttenwesen—September 11, 18, 1897. No. 15860 E.

Safety Catch.

New Safety Catch for Mine Cages. From a communication by E. Flemming to *Glückauf*, of Essen-an-der-Ruhr. Illustrated description of the brake-action safety catch brought out by Gerlach and Bömcke, of the Dortmund Ironworks, Westphalia, with report of trials. 1500 w. Col Guard—Oct. 8, 1897. No. 16035 A.

Surveying.

A Method of Surveying in Inclined Shafts. (Zur Markscheiderischen Vermessung Steiler Schächte.) Describing a practical method for doing accurate theodolite work in shafts inclined at angles of about 70°. 1500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—August 21, 1897. No. 15857 B.

Ventilation.

Some Notes on Mine Ventilation by Furnace. H. W. Halbaum. Describes a ventilating furnace at a large colliery in the north of England, which convinced the writer that in some instances it is better policy to ventilate a mine by means of a furnace rather than a fan, even where a large volume of air is required. 5000 w. Col Guard—Oct. 8, 1897. No. 16034 A.

MISCELLANY.

Firedamp.

Explosives and Firedamp in France. (Les Explosifs et le Grisou en France.) Describing the experiments made by a special commission of experts as to the effect of various mining explosives in igniting mine gases. The explosives were discharged in chambers containing the gases. Two papers. 5000 w. Le Génie Civil—August 7 & 14, 1897. No. 15806 G.

Explosives and Firedamp in Germany. (Les Explosifs et le Grisou en Allemagne.) A review of the Neunkirchen experiments for testing the effect of explosives in igniting firedamp in mines. Two articles. 5000 w. Le Génie Civil—September 25, October 2, 1897. No. 16183 G.

Firedamp and the Means of Preventing Accidents in Mines. (Le Grisou-Moyens de Prevenir les Accidents dans les Mines.) Dealing with the rate of production of gas and the proper degree of ventilation necessary for safety. Serial. Part I. 1800 w. Le Génie Moderne—October 15, 1897. No. 16181 B.

Gas Barrier.

Wagner's Portable Gas Barrier for Mine Gangways. (Wagner's Transportabler Wetterdamm für Bergwerke.) An inflatable air cushion used to close off any portion of a mine containing firedamp or smoke. With numerous illustrations showing the method of application. 3000 w. Glaser's Annalen—Oct. 1, 1897. No. 16190 D.

Metallurgy.

Notes on the Present Western Practice of Metallurgy—Economically Considered. W. B. Devereux. General considerations, with an outline of the more recent metallurgical tendencies and practice. 8500 w. Sch of Mines Quar—July, 1897. No. 16161 D.

Mineral Oils.

The Action of Sulphuric Acid on Mineral Oils. R. Zaloziecki. Translated from the German. Gives results of investigations. 800 w. Am Mfr & Ir Wld—Oct 15, 1897. Serial. 1st part. No. 16021.

Mine Transmission.

See Electrical Engineering, Power.

Onyx.

Onyx Beds in Kentucky. From the St. Louis *Star*. Report of the discovery of the richest and most extensive beds of onyx ever known to exist. 1000 w. Arch & Build—Oct. 2, 1897. No. 15747.

Porphyry.

The Porphyry Dike Mines of Montana. L. A. Sisley. Describes the location, geology, workings, ore, &c. 1200 w. Eng & Min Jour—Oct. 2, 1897. No. 15680.

Smelting.

Pyritic Smelting. W. L. Austin. Abstract of a paper read before the North of England Institute of Engineers. A smelting process aiming to utilize the calorific power of the combustible in the ore. Considers what ores are adapted, the style of furnace, the concentration and saving. 4300 w. Col Guard—Oct. 15, 1897. No. 16133 A.

Tin Deposits.

The Tin Deposits at Temescal, Southern California. Harold W. Fairbanks. Detailed description of the veins and the country in which they are found. 1500 w. Min & Sci Pr—Oct. 16, 1897. No. 16096.

Wire Ropes.

The Statistics of Wire Ropes in Mine Hoists. (Statistik der Schachtförderseile.) Giving interesting data about the life of hoisting cables of various kinds, percentage of breakages from 1882 to 1896, and other information, chiefly from the Breslau mining district. 1200 w. Oesterr Zeitschr f Berg u Hüttenwesen—August 7, 1897. No. 15855 B.

Statistics of the Wire Ropes in the Dortmund Mining District for 1896. (Statistik der Schachtförderseile im Oberbergamtsbezirk Dortmund für das Jahr 1896.) With tabular data from 1872 to 1896, showing the life and efficiency of various makes of wire ropes. 1000 w. Glückauf—September 11, 1897. No. 15864 B.

Ventilation.

Investigations upon Carbonic Oxid in Confined Air. (Rercherche de l'oxide de Carbone dans l'Air Confiné.) Including the use of the "grisoumetre" of Dr. Grehant for determining the proportion of the gas in the air. 3500 w. Le Génie Civil—July 24, 1897. No. 15801 D.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Acetylene.

Calcium Carbid and Acetylene Gas. Consular reports from C. H. Day, of Berlin, and Consul-General Mason, of Frankfort. Gives history of calcium carbid, its production and properties, and discusses the use of acetylene gas. 3800 w. Cons Reports—Nov., 1897. No. 15924 D.

The Use of Acetylene. A. H. Mulliken. Abstract of a paper read before the Fire Underwriters' Assn. of the Northwest, at Chicago. Arguing that it is not a dangerous gas, and will surely find its place. 1300 w. W Elect'n—Oct. 9, 1897. No. 15940.

The Use of Acetylene for the Production of Motive Force. P. Chevillard. Describes experiments by Cuinat showing it possible to obtain a regular working with acetylene, and the cost. 1400 w. Pro Age—Oct. 15, 1897. No. 16019.

Address.

Address of J. Holliday, President of the North of England Gas-Managers' Association. A general review of the industry, the changed conditions, and outlook. 4500 w. Jour Gas Lgt—Oct. 5, 1897. No. 16002 A.

By-Products.

The Sale of Sulphate of Ammonia. Norton H. Humphreys. Discussion of the best way to popularize the use of this product as a fertilizer. 2700 w. Jour of Gas Lgt—Sept. 28, 1897. No. 15764 A.

Cyanogen.

Notes on Cyanogen in the Manufacture of Coal Gas. M. G. Perthius. Gives results of some experiments made by the author on the production of cyanogen in retorts. 900 w. Gas Wld—Oct. 16, 1897. No. 16141 A,

Distribution.

The Distribution of Gas. D. Coats Niven. Remarks on two recent papers on this subject, one American, the other, English. 1200 w. Jour Gas Lgt—Oct. 12, 1897. No. 16079 A.

Exhausters.

The Automatic Regulation of the Speed of Exhausters. Matthew Dunn. Read before the North of England Gas-Managers' Assn. Describes an appliance, and its working, proved to automatically regulate the speed of exhausters when driven either by gas or steam engines. Also discussion. 6800 w. Jour of Gas Lgt—Oct. 5, 1897. No. 16003 A.

Explosions.

Certain Phenomena of Gas Explosions. W. H. Birchmore. Describes experiments, and attempts at experiments, which show that the mechinism of gas explosion is a much more complicated process than is commonly assumed. 4500 w. Am Gas Lgt Jour—Oct. 11, 1897. No. 15906.

Gas Manufacture.

Some Practical Observations on Gas Manufacture. S. Carpenter. Suggestions offered in the hope that they may be of service to those

who have attained responsible positions in gas works because of natural ability rather than liberal education. Deals with the production and purification of gas. 2700 w. Jour of Gas Lgt—Sept. 21, 1897. No. 15647 A.

Gas Supply.

I. New York City Should Own the Gas Supply. Edward M. Grout. II. No Government Should Operate an Industry—A Reply. Allen Ripley Foote. III. A Rejoinder. Edward M. Grout. Papers written at the request of the Committee on Municipal Administration of the Reform Club of New York, presenting the pro and con of this question. 23800 w. Munic Af—June, 1897. No. 15951 C.

Meters.

Amalgamation of Meter Makers. Reports the union of four companies in the North of England, and gives a short account of the origin, progress and present position of each. 1500 w. Gas Wld—Sept. 25, 1897. No. 15712 A.

Philadelphia.

The Philadelphia Gas Works. Clinton Rogers Woodruff. A statement of the condition of gas affairs in this city. 2700 w. Harper's Wk—Oct. 16, 1897. No. 15942.

Retorts.

The Kemmerling System of Mechanical Chargers and Drawers for Gas Retorts. G. Velleman. A description of the Kemmerling apparatus which has been used for four years at Kalk with complete success. Translated from *Revue Universelle des Mines, &c.* 5500 w. Pro Age—Oct. 1, 1897. No. 15743.

SEWERAGE.

Construction.

Improved Method of Sewer Construction. (Nouveau Mode de Construction des Souterrains.) M. Bechmann. Describing the improved method of tunneling under city streets without disturbing the surface, using shields operated by hydraulic cylinders, as employed in the new Clichy sewer at Paris. 10000 w. 1 plate. Ann des Ponts et Chaussées—Part I. 1897. No. 15871 F+G.

House Drainage.

The Principle of Delivering all Drainage into the Sewer. (De l'Application du "Tout-à-l'Egout.") A discussion of the importance of doing away with cesspools and wells and the delivery of everything to the sewer, accompanied by an ample flow of water for flushing and dilution. 2500 w. Le Génie Civil—Oct. 9, 1897. No. 16186 D.

Paris.

The Aqueduct and Sewage Farm at Achères. (L'Aqueduct et le Parc Agricole d'Achères.) A very complete and fully illustrated account of this great sewerage work at Paris. 70000 w. 10 plates. Ann des Ponts et Chaussées—Part II. 1897. No. 15873 F+G.

Purification.

Plans for the Sewage Purification Plant at Spandau. (Entwurf zur Kanalwasser-Reinigungs-Anlage für Spandau.) Describing the pumping, settling and purifying plant intended to permit the discharge of the sewage of the city into the Havel; the oxid of iron process is the method adopted. 4500 w. Gesundheits-Ingenieur—Sept. 15, 1897. No. 15840 B.

Sewage Disposal.

Sewage Disposal on Land at Litchfield, Conn. Information of a satisfactory system. 500 w. Eng News—Oct. 28, 1897. No. 16213.

Sewer Gas.

Deadly Sewer Gas. Report of William Attlesey on the disaster in Newport, Ky., which caused destruction of life and property. 1800 w. Dom Engng—Oct., 1897. No. 16043 C.

STREETS AND PAVEMENTS.

Artificial Stone.

Artificial Stone Pavements. Robert Grimshaw. Describing the present state of the art in Europe. 1000 w. Munic Engng—Oct., 1897. No. 15728 C.

St. Louis.

Pavements for City Streets. Sectional views of streets in St. Louis, showing the method of construction adopted in laying the various forms of pavement. Also specifications. From a pamphlet issued by the street commissioner of St. Louis, Missouri. 4000 w. Sci Am Sup—Oct. 9, 1897. No. 15768.

Street Cleaning.

The Labor Question in the Department of Street Cleaning of New York. George E. Waring, Jr. Explains the features of the scheme which has proved a most gratifying success in the management of this department. 3500 w. Munic Af—Sept., 1897. No. 15955 C.

Subsurface Constructions.

A Lesson on the Necessity of Systematic Work in Subsurface Street Constructions. Editorial presenting facts regarding the Fifth avenue work in New York, and the lessons to be learned from them. 3200 w. Eng News—Oct. 21, 1897. No. 16089.

WATER SUPPLY.

Aeration.

Purifying Water by Aeration. Extracts from article by Dr. Heysinger, who believes that before many years aeration will be resorted to as the only means of purifying water. 1600 w. Fire & Water—Oct. 9, 1897. No. 15799.

Birmingham.

Birmingham Corporation Water Works. H. Davey. Abstract of paper read at recent meeting of the Inst. of Mech. Engs. in Birmingham, Eng. History of the undertaking, the present condition, reservoirs, &c. 3200 w. Jour Gas Lgt—Sept. 28, 1897. No. 15765 A.

Broken Main.

Serious Break in a Water Main. An account of the damage caused by the breaking of a main at Madison avenue and Forty-second street, New York. Ill. 900 w. Fire & Water—Oct. 16, 1897. No. 15997.

Budapest.

The Water Supply of Budapest. (Alimentation d'Eau de Budapest.) Illustrated account of filter plant, pumping station, and reservoirs for the supply of the city of Budapest. 4000 w. 1 plate. Le Génie Civil—July 31, 1897. No. 15804 D.

Electrolysis.

Electrolysis and Water Mains in Salt Lake City, Utah. Summary of opinions regarding the indications and causes of electrolytic action and methods of determining the location as given in report of F. C. Kelsey, in a paper read before the Denver Convention of the American Water-Works Assn. 5000 w. Eng Rec—Oct. 16, 1897. No. 16057.

Epidemic.

The Maidstone Epidemic. Editorial on the impure water supply that has caused the serious epidemic of typhoid in this district of England. 1000 w. Engr, Lond—Oct. 1, 1897. No. 15920 A.

Filtration.

Another Court Decision Regarding the Use of a Coagulant in Mechanical Filters. Decision rendered in the United States by Judge Coxe regarding the use of alum or other coagulants in mechanical filters being an infringement of the Hyatt patent. 1200 w. Eng. News—Sept. 30, 1897. No. 15661.

Bacterial Test of Mechanical Filters at Lorain, O. Taken from the *Ohio Sanitary Bulletin*. Valuable information regarding the bacterial efficiency of mechanical filtration, with editorial comment. 5800 w. Eng News—Oct. 28, 1897. No. 16208.

The Filtration of Water. Edmund B. Weston. Read before the National Convention of Mayors and Councilmen, at Columbus, O. Discusses and describes the purification of water by sand filtration, and by mechanical filtration aided by the application of chemicals. 4800 w. Munic Engng—Oct., 1897. No. 15729 C.

Fire Supplies.

Rules for the Use of Private Fire Supplies Providence Water-Works. Reprinted from the official rules issued by Robert E. Smith, Commissioner of Public Works. 900 w. Eng News—Oct. 28, 1897. No. 16209.

Forest Denudation.

Effect of Forest Denudation on Water Courses and Water Supply. Daniel W. Baird. Abstract of a paper presented at the annual convention of the American Forestry Assn., at Nashville, Tenn. Notes the fact that the water-level of certain districts has fallen many feet, and shows that if forest growths do not increase the rainfall, they help retain what does fall. 1100 w. Eng News—Oct. 21, 1897. No. 16083.

Jersey City, N. J.

The Latest Jersey City Water-Supply Specifications. Outline of the specifications, prepared from information furnished by C. C. Vermeule. 450 w. Eng News—Sept 30, 1897. No. 15664.

Pipe Joints.

The Packing of Terra Cotta Pipes. (Ueber das Dichten von Steingutröhren.) Describing improved methods of making tight bell joints with terra cotta drain pipe with especial reference to the use of asphalt. 4000 w. Gesundheits Ingenieur—August 31, 1897. No. 15838 B.

Pipes.

The Practical Computation of the Resistances in Pipes. (Ein Beitrag zur Berechnung des Rohrwiderstandes in der Praxis.) With particular reference to the flow of water in cast iron pipe; friction due to incrustation, influence of slope, &c. 6000 w. Gesundheits Ingenieur—September 15, 1897. No. 15839 B.

Pumping Engine.

Test of a 30,000,000 Gallon Pumping Engine at Buffalo, N. Y. Description, with front elevation, of the vertical triple-expansion pumping-engine, built for the Buffalo City Water Works, and report of the high duty obtained on the official test. 1200 w. Eng News—Sept. 30, 1897. No. 15657.

The D'Auria Pumping Engine. Illustrated description of an engine which is a development in the direct-acting duplex type, and report of tests. 1100 w. Engng—Oct. 8, 1897. No. 16038 A.

The William Radcliffe Pumping Engine, Aubrey-Street, Liverpool. Alfred Towler. Read before the British Assn. of Waterworks Engineers. Illustrated description of an up-to-date pumping engine, with a summary of results of the official duty trial. 4700 w. Engr, Lond—Oct 15, 1897. No. 16140 A.

Triple-Expansion Vertical High-Duty Worthington Pumping-Engine. Report of two trials recently carried out by W. C. Unwin, at Hampton Pumping Station for the West Middlesex Waterworks. Gives general description of the engines. Ill. 5500 w. Engr, Lond—Sept. 24, 1897. No. 15690 A.

Pumping Station.

Chestnut Hill Pumping Station, Boston. Illustrated description. 3500 w. Fire & Water—Oct. 16, 1897. No. 15996.

Reservoir.

The Wolfsgraben Reservoir and the High Water of July 30, 1897. (Das Wolfsgraben-Reservoir und das Hochwasser vom 30 July, 1897.) An interesting account of the relief of the reservoir of the Vienna water supply during heavy flood. With photographs of the overflow canal taken at close intervals of time. 3500 w. Oesterr Monatschr f d Oeffent Baudienst—Oct., 1897. No. 16197 D.

Reservoir Accident.

Accident to a Concrete-Covered Reservoir at Wellesley, Mass., While Under Construction. Illustrated account of the falling of a portion of the roof of a concrete-covered reservoir. 450 w. Eng News—Sept. 30, 1897. No. 15663.

Sterilization.

Sterilization of Impure Water by Ozone. E. Andreoli. Reports favorable to the use of ozone for this purpose, and recommends that its efficiency be tried in small towns and villages. 1500 w. Elec Rev, Lond—Oct. 15, 1897. No. 16123 A.

Syracuse.

Syracuse, N. Y., Water-Works. William R. Hill. Historical account, with description, cost, rates, consumption, &c. Ill. 3300 w. Fire & Water—Oct. 2, 1897. No. 15731.

Typhoid Fever.

The Effect of a Pure Water Supply on Typhoid Fever in Newark and Jersey City, New Jersey. Report of the remarkable decrease following the change to pure water, with interesting particulars. 2000 w. Eng News—Sept. 30, 1897. No. 15659.

Water Mains.

Are the Water Mains in Danger? Discusses the difficulties from the laying of underground electric trolley tracks on Amsterdam avenue, New York. 900 w. Fire & Water—Oct. 23, 1897. No. 16119.

Machines for Inserting Valves and Branches in Water Mains under Pressure. A brief illustrated description of the devices and methods of operating them. 1300 w. Eng News—Oct. 28, 1897. No. 16212.

Water-Tower.

The Water Tower at Nijni-Novgorod. (Le Chateau-d'Eau de Nijni-Novgorod.) The tower is made of straight bars of iron in the form of a hyperboloid of revolution, giving great strength and extreme simplicity of construction, all members being alike. An ingenious and effective idea. 1000 w. Le Génie Moderne—Sept. 15, 1897. No. 15834 B.

Water-Works.

The Financial Management of Water-Works. E. Kuichling. Condensed from annual report of the Executive Board of the city of Rochester, N. Y. Discussion of how the works may be conducted on business principles. 3800 w. Munic Engng—Oct., 1897. No. 15730 C.

Williamsport, Pa.

Water Supply of Williamsport. Comments on the exceptional purity of the supply and the care necessary to keep it so, with other information. 1000 w. Fire & Water—Oct. 23, 1897. No. 16120.

MISCELLANY.

Address.

Professor Ramsay's Address before the British Association, at Montreal. Abstract of the address on the "undiscovered gas" whose place lies between argon and helium. 1700 w. Engng—Oct. 8, 1897. No. 16036 A.

City Noises.

To Abate the Plague of City Noises. John H. Girdner. Presents the effect of unnecessary noise on the public health and comfort, and offers suggestions for lessening the disturbance. 3000 w. N Am Rev—Oct., 1897. No. 15725 D.

Consulting Engineers.

Are Consulting Engineers a Necessity or a Luxury? The duties of consultants, their qualifications, power, &c., are considered, with opinion as to when they are necessary, and when a luxury. 1800 w. Elec, Lond—Sept. 24, 1897. No. 15711 A.

The Consulting Engineer in Municipal Affairs. William H. Searles. Shows the necessity of an engineering department of a great city, the growth of the work as the city increases in size, and the advisability of employing a consulting engineer that the work may be properly carried on. 3000 w. Jour Assn of Eng Soc—Sept., 1897. No. 15992 C.

Garbage.

The Disposal of Garbage and Refuse. Rudolph Hering. Gives information of the construction, cost, and operation of the Hamburg, Germany, works, with illustrations. 4500 w. Eng Rec—Oct. 23, 1897. No. 16128.

The Sanitary Disposal of Garbage. Abstract of discussion taken from Proceedings of the Massachusetts Assn. of Boards of Health. Discusses the feeding garbage to stock, burying, cremation, reduction, &c. 6500 w. San—Oct., 1897. No. 15744 D.

Public Works.

The Management of Public Works in Greater New York. Reports concerning the provisions of the new charter for the administration of the public works of this great municipality. 4500 w. Eng Rec—Oct. 30, 1897. No. 16248.

Report.

Report of the Committee on Photometry of the German Gas and Water Works Association. (Bericht über die Arbeiten der Lichtmess-Kommission des Deutschen Vereins von Gas-und Wasser fachmännern.) A review of the bulky report of this important committee dealing with the subject of photometric units and methods, and the comparison of various illuminants. 1200 w. Gesundheits Ingenieur—August 31, 1897. No. 16355 B.

Roads.

The New Road-Law of Montana. M. S. Parker. Discusses the recently enacted law, making county surveyors general superintendents of all roads in their counties. 2000 w. Jour Assn of Eng Soc—Sept., 1897. No. 15991 C.

Smoke Prevention.

Progress in the Matter of Smoke Abatement. (Fortschritte auf dem Wege zur Russbeseitigung.) With especial reference to the devices recently tried in Berlin and Dresden. 2500 w. Gesundheits-Ingenieur—August 31, 1897. No. 15837 B.

Street Lighting.

Chaotic Condition of Our Street-Lighting System as to Cost, etc. D. Hunter. Read before the National Street-Lighting Assn., Columbus, O. Statistics of cost in a number of cities in various States are given and comparison made. 1300 w. Elec Eng, N Y—Oct. 7, 1897. No. 15756.

Street Lighting by Contract and by Municipal Ownership. John McVicar. Abstract of a paper read before the Mayor's Convention, Columbus, Ohio. Consists mostly of an account of experience in Des Moines, Ia. 1400 w. Elec Eng, N Y—Oct 7, 1897. No. 15755.

Street Railways.

See Street and Electric Railways.

RAILROAD AFFAIRS.

NEW CONSTRUCTION.

China.

The Eastern Railway of China. (Le Chemin de Fer de l'Est de la Chine.) Discussing the Chinese railway in connection with the Siberian system and the gold deposits in Manchuria, with topographical map of existing and proposed lines. 3500 w. Le Génie Civil—September 11, 1897. No. 15815 D.

Improvements.

Monon Improvements. An illustrated account of the work of eliminating curves and grades near Cedar Lake, Indiana. 1000 w. Ry Age—Oct. 22, 1897. No. 16151.

Indian Railways.

A Remarkable Indian Railway. Interesting account of the Mushkaf-Bolan Railway in Baluchistan. 2700 w. Trans—Oct. 8, 1897. No. 16069 A.

Jungfrau.

The Jungfrau Railway. L. Bayly. Interesting illustrated description of this great engineering work. 1800 w. Engr, Lond—Oct. 1, 1897. No, 15919 A.

Santo Domingo.

The Central Dominican Railway. Brief description of the second line of railway to be built in this republic, which was recently opened for traffic. 800 w. Eng News—Oct. 21, 1897. No. 16085.

MAINTENANCE OF EQUIPMENT.

Air Braking.

Modern Compressors for Air-Braking. E. J. Wessels. Illustrated description of a compressor of the single-acting type, with double cylinders which are placed vertically, with trunk pistons connecting directly to eccentrics in crank case. 1200 w. Elec Rev, N Y—Oct. 20, 1897. No. 16047.

Box Cars.

New Box Cars for the Big Four. Description, with engravings of details, of the 1000 box cars which Pullman's Palace Car Co. has lately built for the Cleveland, Cincinnati, Chicago & St. Louis R. R. 1200 w. R R Gaz—Oct. 29, 1897. No. 16216.

Brakes.

Experiments Upon Auxiliary Reservoirs. G. R. Henderson. Graphical representation of the effects of varying the capacity of the auxiliary reservoir for a given size of brake-cylinder, with explanation. 800 w. Am Eng & R R Jour—Oct., 1897. No. 15652 C.

Brake Shoe.

A New Brake-Shoe. Illustrated description of shoe called the "Diamond S." offered by the Sargent Company of Chicago. It consists of a bundle of expanded metal sheets of steel about which molten iron is cast. 1400 w. Ry Mas Mech—Oct., 1897. No. 15665.

Car Construction.

Malleable Iron in Car Construction and Repairs. Eugene Chamberlin. Read before the Central Railway Club. Facts with relation to the benefits obtained from its general use. 1500 w. Pro of Cent Ry Club—Sept., 1897. No. 15750 D.

Car Lighting.

The Lighting of Cars by Electricity. (L'Eclairage Electrique des Wagons.) A very full review of experience and practice in France, Switzerland, Italy and Germany, with details of arrangement and data of cost. Three articles. 7000 w. Le Génie Civil—July 31, August 7 & 14, 1897. No. 15805 H.

Freight Cars.

New Freight Cars for the Mexican Central. An order for about one thousand cars, including box, coal, and stock cars is being filled for this road, and the engravings and description show the construction in detail. 1100 w. R R Gaz—Oct. 8, 1897. No. 15776.

Locomotive Car.

Locomotive Car on the New England Railroad. Describes a combination car and locomotive, giving illustration of the locomotive. 800 w. Ry Rev—Oct. 16, 1897. No. 16062.

Locomotives.

American Express Locomotives. Angus Sinclair. Extract from article in *Pall Mall Magazine*. Remarks on the changes that follow railroad construction, the early locomotives, the progress and the claim of American locomotives of being less complicated than others. 1800 w. Loc Engng—Oct., 1897. No. 15649 C.

Express Locomotive for the Midland Railway, England. Two page engraving, with other views, description and dimensions of the most recent type of express-passenger engine, designed by S. W. Johnson for service of fast trains on this line. 1500 w. Engng—Oct. 15, 1897. No. 16125 A.

New Locomotives on the Chicago, Rock Island & Pacific Railway. A half tone illustration of one of the passenger engines, with dimensions. 400 w. Ry Rev—Oct. 16, 1897. No. 16065.

North-Eastern Engines and Their Work. Charles Rous-Martin. A record of the work that has been done by these English engines, under the personal observation of the writer. Proves them to be highly satisfactory. 3000 w. Engr, Lond—Sept. 24, 1897. No. 15687 A.

Passenger Locomotive, Great Western Railway. Illustration and general dimensions. 200 w. Engr, Lond—Oct. 8, 1897. No. 16028 A.

Special Mountain Freight Engine for the Mexican Central Railway. Illustrated description of the largest engine made at the Brooks Locomotive Works, with its interesting features. 2000 w. R R Gaz—Oct. 29, 1897. No. 16215.

Ten-Wheel Freight Engine, Chicago &

Northwestern Railway. Illustration, dimensions and other particulars. 750 w. R R Gaz—Oct. 29, 1897. No. 16219.

Ten-Wheel Passenger Locomotive—Atchison, Topeka & Santa Fe. Illustrated detailed description with general dimensions. 1200 w. R R Gaz—Oct. 22, 1897. No. 16092.

The Hagens Coupled Locomotive. Description, with illustration, of a 70-ton engine with four coupled axles, for steep gradients and sharp curves. The chief dimensions are given. 600 w. Engng—Oct. 8, 1897. No. 16039 A.

Von Borries Four-Cylinder Compound Locomotive. Translated from an article by Herr Von Borries in *Glaser's Annalen*. A general description with comparison of the new locomotives with those previously built, stating the advantages. Also editorial. 3000 w. Am Eng & R R Jour—Oct., 1897. No. 15663 C.

Various Locomotive Cylinders. Clement E. Stretton. Consideration of locomotives with one, two, three and four cylinders. 1300 w. Mech Wld—Oct. 15, 1897. No. 16122 A.

Lubrication.

See Mechanical Engineering, Miscellany.

Painting.

Is it Advisable to Rub to a Dead Finish the Interior of Passenger Cars? What is the Extra Cost? Papers by Robert McKeon, R. G. Barinowski and C. A. Bruyere read at meeting of the American Master Car and Locomotive Painters' Assn., with discussion. 6000 w. R R Car Jour—Oct., 1897. No. 15673.

Painting Railway Equipment with Compressed Air. Papers by Messrs. McMasters, Kahler and Copp, read before the American Master Car and Locomotive Painters' Assn., with discussion. 9000 w. R R Car Jour—Oct., 1897. No. 15670.

Private Car.

President McKinley's Inauguration Car. Illustrated description of the car used to convey President McKinley from Canton, Ohio, to Washington to be inaugurated. 500 w. Ry Mag—Aug., 1897. No. 15676 C.

Protective Paint.

Protective Paint for Metal Parts of Cars and Trucks. Papers by J. H. Pitard and A. Hunicke, read before the American Master Car and Locomotive Painters' Assn., with discussion. 6500 w. R R Car Jour—Oct., 1897. No. 15668.

Repairs.

See same title under Mechanical Engineering, Boilers, Furnaces and Firing.

Roller Bearings.

Comparative Test of Roller Bearings. Reports a test recently made by the Union Railroad Company, Providence, R. I., to determine the saving in power, if any, by the use of roller bearings for the car axles as compared with the solid bearings ordinarily in use. The saving was shown to be 13 per cent. of the whole power consumed. 800 w. Am Mach—Oct. 21, 1897. No. 16100.

Springs.

Helical versus Elliptical Driving-Springs. Edward Grafstrom. Describes a trial of helical springs made at the writer's suggestion and gives the favorable results of the experiment. 2000 w. R R Gaz—Oct. 1, 1897. No. 15682.

Surfacing.

What Methods of Surfacing Will Give Fairly Good Results Without the Use of Either Sandpaper or Lump Pumice-stone for Passenger Cars or Locomotive Tenders. Papers by C. E. Koons and C. A. Cook read before the American Master Car and Locomotive Painters' Assn., with discussion. 5500 w. R R Car Jour—Oct., 1897. No. 15669.

MAINTENANCE OF WAY.

Bridge Floors.

Bridge Floors. Report of committee on open floors for railway bridges. Illustrations of different types are given. 3200 w. American Assn of Ry Supts of Bridges and Buildings. No. 15947 D.

Bridge Warnings.

Bridge Warnings for Low Overhead Structures. Committee report on the systems in use, mentioning the important characteristics and practical features, and an appendix containing descriptions and illustrations of a large variety of bridge warnings. 4000 w. American Assn of Ry Supts of Bridges & Buildings. No. 15946 D.

Gage.

Should the Gage of Railway Track be Widened on Curves? Abstract of replies received to questions bearing on this subject, sent out by the committee of the American Railway Assn. 4000 w. Eng News—Oct. 14, 1897. No. 15974.

Ice-Houses.

Designs for Ice-Houses. Report of committee, discussing the quantity of ice, how obtained and delivered, and general requirements, with opinions on manufactured ice; also the designs of ice-houses with plans of two storage houses. 6500 w. American Assn of Ry Supts of Bridges and Buildings. No. 15945 D.

Lateral Pressure.

The Lateral Pressure upon Rails due to the Rotation of the Earth. (Die Seitliche Verschiebung der Eisenbahnschienen in Folge der Achsendrehung der Erde.) A mathematical analysis by Dr. Koller, showing that the pressure due to the rotation of the earth is so slight as to be negligible. 2500 w. Glaser's Annalen—September 15, 1897. No. 16188 D.

Rails.

New 100-lb. Rail and Splice Bars for the Illinois Central R R. Section, dimensions and brief description. 300 w. Eng News—Oct. 21, 1897. No. 16088.

Replacing Bridge.

Replacing Bridge No. 69, Pennsylvania R R., near Girard Ave., Philadelphia. Jos. Wood Wagner. Description, with illustration, of the replacing of a Whipple-truss bridge, with a Pratt truss, the work consisting of the bodily removal of the old and substitution of the new

span, so as not to interrupt the traffic between Philadelphia and New York. 2000 w. Eng News—Oct. 21, 1897. No. 16082.

Station.

New Union Station at Columbus, O. Description, with illustration, plan and sections of a very elaborate railway building recently completed. 1300 w. Ry Rev—Oct. 16, 1897. No. 16063.

The Providence, R. I., Station of the New York, New Haven, and Hartford. Calling attention to special points in these new railroad-station buildings. Ill. 900 w. R R Gaz—Oct. 1, 1897. No. 15681.

St. Lawrence Bridge.

See Civil Engineering, Bridges.

Stock-Yards.

Stock-Yards and Stock-Sheds, Including All Details of Construction. Numerous plans showing the practice of different railways, with brief report of committee. 1200 w. American Assn of Ry Supts of Bridges and Buildings. No. 15948 D.

Swing Bridge.

See Civil Engineering, Bridges.

Switchback.

The Cascade Switchback and Tunnel of the Great Northern. Map and profile of the tunnel and switchback, with account of the manner of handling the trains over the switchback, the distance saved by the tunnel, and other matters of interest. 700 w. R R Gaz—Oct. 15, 1897. No. 15960.

Ties.

Average Life of Cross-Ties in Steam Railroads in Colorado. William Ashton. Reports concerning ties used in Colorado, and the life of the different kinds used, with remarks on metallic ties. 1200 w. Jour Assn of Eng Soc—Sept., 1897. No. 15993 C.

Tie Preserving. S. M. R. Letter to the editor containing facts from the experience of the writer as to the value of tie preserving. 1000 w. Ry Rev—Oct. 9, 1897. No. 15937.

Track Elevation.

Progress of Track Elevation by the Chicago & Northwestern Railway in Chicago. An account of rapid work. 1000 w. Eng News—Oct. 28, 1897. No. 16214.

Tracks.

Wood Screws and Spikes for Railroad Track Use. A. Morrison. Considers the movements of the several parts comprising the track that affect the spike or screw, and the relative merits of wood-screws and spikes in holding the rail and cross-tie together. 1600 w. R R Gaz—Oct. 15, 1897. No. 15961.

Waterways.

How to Determine Size and Capacity of Openings for Waterways. Committee report of methods actually adopted on railroads to obtain quick and practical results. 8800 w. American Assn of Ry Supts of Bridges & Buildings. No. 15944 D.

SIGNALING.

Automatic.

The Arrangement of Signals with Electrical Release for Operation by the Train. (Einrichtung von Mastsignalen mit Elektrischer Auslösung durch die Züge.) Description and details of the system by which the block signal is automatically set for "clear track" when the train leaves the block. 5000 w. Oesterr Monatschr f d Oeffent Baudienst—Oct., 1897. No. 16199 D.

Caution Signal.

The Caution Signal in the Proposed West Arlington Signaling. C. C. Anthony. Letter to the editor criticising the use of the caution signal in the scheme proposed for the West Arlington draw-bridge, and showing why it is objectionable. 2400 w. R R Gaz—Oct. 8, 1897. No. 15775.

Interlocking.

Definitions of and Regulations for the Use of Interlocking Switches and Signals. A reprint of the additions adopted by the American Railway Assn., Oct. 6, 1897. 1800 w. R R Gaz—Oct. 15, 1897. No. 15964.

Pflasterer's Combined Switch and Distant-Signal Movement. Illustrated description of a recent patent. The parts are operated by a single lever, which is thrown one way to set the signal and open the switch, and in the opposite direction to close the switch and clear the signal. 1200 w. R R Gaz—Oct. 15, 1897. No. 15962.

Rules for the Operation and Maintenance of Interlocking Plants. A copy of the rules for operation and maintenance, recommended by the Railway Signaling Club. 2500 w. R R Gaz—Oct. 15, 1897. No. 15965.

Signals.

See same title under Mechanical Engineering, Compressed Air.

TERMINALS AND YARDS.

English Stations.

English Goods Stations and Railway Yards. Arch. R. Whitehead. An account of the growth of English goods stations both at terminals and elsewhere, with many illustrations of stations and yards of the principal railways. 4000 w. Engineering Magazine—Nov., 1897. No. 15596 B.

Paris.

The Work of the Western Railway of France in Paris. (Les Travaux Parisiéns de la Compagnie del'Ouest.) Giving an account of the local and terminal extensions in Paris for the handling of the traffic of the Exposition of 1900. 5000 w. Map and profile. Le Génie Moderne—Oct. 1, 1897. Serial, Part 1. No. 15835 B.

Two Harbors, Minn.

Two Harbors Terminal of the Duluth & Iron Range Railroad. Illustrated description of the dock yards and terminals; the design of the yard and approaches to the ore-docks are a fine example of railroad construction. 800 w. Ry Rev—Oct. 9, 1897. No. 15938.

TRANSPORTATION.

Accidents.

English Railroad Accidents in 1896. Facts taken from the general report made by Secretary Hopwood. 1500 w. R R Gaz—Oct. 15, 1897. No. 15966.

The New York Central and Hudson River R. R. Wreck Near Garrisons, N. Y. An account of the disaster which cost the lives of twenty-one persons, with editorial. 2000 w. Eng News—Oct. 28, 1897. No. 16210.

Train Accidents in the United States in August. Detailed list with classified summary. 3400 w. R R Gaz—Oct. 1, 1897. No. 15684.

Train Accidents in the United States in September. Detailed list, with classified summary and editorial. 5000 w. R R Gaz—Oct. 29, 1897. No. 16217.

Earnings.

September's Heavy Railroad Earnings. Reports railroad earnings in the United States even more satisfactory than in August. 3500 w. Bradstreet's—Oct. 16, 1897. No. 16000.

Long Run.

A Long Locomotive Run. Locomotive performance made between Evanston, Wyo., and Omaha, Neb., on the Union Pacific, Aug. 3, and 4, 1897. Official figures. 900 w. R R Gaz—Oct. 22, 1897. No. 16095.

Passes.

Pass-Selling in Illinois. Editorial on a bill passed by the Illinois Legislature to prevent buying, selling or fraudulently using passes. 600 w. Ry Age—Sept. 10, 1897. No. 15303.

Report.

Eleventh Annual Report of the Denver & Rio Grande R R. Summary of operations presented to the stockholders by E. T. Jeffrey, with editorial. 1500 w. Ry Rev—Oct. 23, 1897. No. 16158.

Tickets.

Kilometric Tickets and Ticket Money. (Carnets Kilometriques et Tickets-monnaie.) Discussing the question of mileage tickets and also the sale of reduced rate coupons in quantity for subsequent use in purchase of railway tickets. 1600 w. Le Génie Civil—September 4, 1897. No. 15813 D.

MISCELLANY.

Braking.

Train Acceleration and Braking. W. B. Potter. Presents fundamental formulæ and endeavors to show how far they are borne out by actual tests. 1600 w. St. Ry Jour—Oct., 1897. No. 16009 D.

Coal Handling.

Some Modern Methods of Loading Coal. Illustrated description of some of the systems in use. 2400 w. Ir & Coal Trs Rev—Oct. 8, 1897. Serial. 1st part. No. 16066 A.

Celebration.

Twenty five Years of Progress. An illustrated account of the celebration of the Atchison, Topeka & Santa Fé's quarter century of active life, with addresses by E. P. Ripley and Aldace F. Walker. Ill. 2800 w. Ry Age—Oct. 8, 1897. No. 15936.

Color-Vision.

Standards of Form and Color-Vision Required in Railroad Service. Charles H. Williams. A paper read at meeting of the American Ophthalmological Society, in Washington. Some information of the standards of vision required on different roads, with discussion of what should be required, and suggestions. 5500 w. R R Gaz—Oct. 8, 1897. No. 15777.

Combination.

The Grand Trunk System and the Central Vermont. An account of the terms on which the Grand Trunk Railway Company have received absolute control of the Central Vermont system, with brief history of the latter road. Map. 900 w. Ry Age—Oct 22, 1897. No. 16150.

English Railways.

Home Railways as Investments. A discussion of the indications that English railways as investments are coming again into favor. 3700 w. Trans—Oct. 1, 1897. No. 15923 A.

France.

The Administration of Six Great French Railway Systems. (Quelques Chiffres sur l'Exploitation des six Grand Reséaux Français.) A comparative study of financial management with diagrams and tabulated statements. 2500 w. 1 plate. La Revue Technique—Sept 10, 1897. No. 15879 D.

Heating.

See also Architecture and Building, Heating.

High Railroading.

The Highest Adhesive Railroad in Europe. Simon Linden. Describes and illustrates the Davos-Landquart-Thusis Railroad, which runs through a very mountainous part of eastern Switzerland. 600 w. Loc Engng—Oct., 1897. No. 15648 C.

Light Railways.

Light Railways. Editorial inquiry into the saving of expense alleged for this class of road, because of lesser cost of construction. 1800 w. Engr, Lond—Oct. 8, 1897. No. 16030 A.

Management.

Colonial Railway Management. Commendatory of the Australian railways, giving results as taken from the annual report of 1896-7. 1500 w. Trans—Oct. 8, 1897. No. 16070 A.

Motive Power.

Application of Electricity to Railroads Now Operated by Steam Power. N. H. Heft. Abstract of paper read at convention of the American Street Railway Assn. Reviews the work of the New York, New Haven and Hartford Railroad Company in heavy electric railroading, giving the results. 3800 w. Elec Wld—Oct. 23, 1897. No. 16165.

Electric Motive Power. W. H. Weston. Thinks it a mistake to use it in any extended way for motive power purposes. 2400 w. Ry Mag—Sept., 1897. No 16159 C.

Prices.

How Can the Elementary Rate-Fixing Be Best Attained for Use in Establishing Piece-Work Prices in the Railway Paint-Shop? Papers by Messrs. Ball and Lanfersiek read before the American Master Car and Locomotive Painters' Assn. 2400 w. R R Car Jour—Oct., 1897. No. 15671.

Railroads.

"Railroads—the World's Greatest Benefactors." W. S. Glover. On the civilizing and educating influence of railroads. 3300 w. Ry Mag—Aug., 1897. No. 15675 C.

The People and the Railroads. J. B. Flemming. Argument before the Georgia railroad commission which clearly sets forth the relations of the railroads, the people, and the state. 1500 w. Mfrs Rec—Oct. 1, 1897. No. 15646.

Railroad Relics.

The Field Columbian Museum and Railroad History. Herbert T. Walker. Information of this collection of relics, models, photographs and drawings, in Chicago, illustrating the development of transportation and motive power from the year 1680 to the present time. 1100 w. R R Gaz—Oct. 22, 1897. No. 16094.

Statistics.

Statistics of Railways in the United States for the year ending June 30, 1896. Figures from the advance abstract of the ninth annual statistical report of the Commission. 1400 w. Eng News—Oct. 21, 1897. No. 16091.

U. S. Railways.

The Railroads of the United States. Reasons why American railroad shares do not readily find a market in England, with review of results for the last three years as given in "Poor's Manual." 1500 w. Trans—Sept. 24, 1897. No. 15708 A.

Ventilation.

The Ventilation of the Metropolitan Railway. Editorial on the "Blue-book" just issued by the Board of Trade Committee appointed to report on the London underground railway, as to the quality of the air, and the remedy. 2000 w. Engr, Lond—Oct. 15, 1897. No. 16138 A.

STREET AND ELECTRIC RAILWAYS.

Accidents.

A Chapter of Accidents. William J. Clark. Calls attention to the exaggeration of street-railway accidents, and presents statistics bearing upon the matter, aiming to state the facts exactly as they are. 2800 w. St Ry Jour—Oct., 1897. No. 16008 D.

The Best Method of Settling Damage Cases and the Prevention of Accidents by the Use of Fenders or Otherwise. Willard J. Hield. Read before the American Street Railway Assn. Discussion of the subjects, considering points of particular interest. 1400 w. Elec Eng, N. Y—Oct. 21, 1897. No. 16170.

Air Braking.

See also Railroad Affairs, Maintenance of Equipment.

Binghamton, N. Y.

The Binghamton, N. Y., Electric Railroad. Harry N. Gardner. Illustrated detailed description. 2000 w. Elec Eng, N. Y—Oct. 14, 1897. No. 16045.

Braking.

Recent Tests of Acceleration and Braking. Report of tests made by the engineers of the American General Electric Co. to find out the maximum rate of acceleration that could be imparted to a car without discomfort to the passengers. Also a consideration of rapid braking. 1800 w. Eng News—Oct. 14, 1897. No. 15973.

Cable Line.

Cable Line Operated by Electric Motor. Charles Grover. Describes and illustrates the motor-driven cable-plant at Kansas City, Mo., and shows the economy resulting from change of power from steam to electricity. 1200 w. St Ry Rev—Oct. 15, 1897. No. 15986 C.

Chicago Elevated.

Elevated Railway Progress in Chicago. Reports the use of the Union Loop since Oct. 3 by one road, and the preparations of other roads to soon use it. Gives also information relating to the loop. Ill. 1300 w. W Elect'n—Oct. 9, 1897. No. 15939.

Raising the Metropolitan West-Side Elevated Railway of Chicago. Illustrated description of work made necessary by the elimination of railway crossings at grade, along Rockwell street, where the elevated road crosses the tracks of two surface roads. 2500 w. Eng News—Sept. 30, 1897. No. 15656.

Distribution.

Distribution of Street-Railway Mileage and Capitalization in America. Tables of interesting statistics with remarks on the great expansion in mileage and capital investment since 1880. 1500 w. St Ry Jour—Oct., 1897. No. 16007 D.

Dover, England.

Dover Municipal Electric Tramways. Illustrated detailed description. 5500 w. Ry Wld—Oct., 1897. No. 15995 A.

Dynagraph.

A Dynagraph Car for Street Railways. Illustrated description of the principal features of a dynagraph car for recording defects in street-railway track, which has been in successful use in Chicago. 1300 w. Eng News—Oct. 14, 1897. No. 15972.

Economy.

Economy in Electric Car Control. J. R. Cravath. Read before the Chicago Electrical Assn. Discusses the economy possible by correctly handling the controller, and the need of records being kept that will serve as an in-

centive to motormen to give attention to the matter. 4000 w. W Elect'n—Oct. 9, 1897. No. 15941.

Electrolysis.

The Latest Method of Electrolysis Prevention. Harold P. Brown. A comparison of European and American requirements, brief explanation of the cause of electrolysis, describing a method of prevention designed by the writer. Ill. 2200 w. Elec Eng, N. Y—Oct. 14, 1897. No. 16046.

Engines.

Engines for Electric-Railway Power-Stations. Charles E. Emery. Some remarks on the general subject of engine building, with description of a number of the more prominent steam engines for operating electric-railway generators. Ill. 16000 w. St Ry Jour—Oct., 1897. Serial. 1st part. No. 16005 D.

European Practice.

Street Railway Engineering in Europe. G. H. B. Zahn. Part first consists of general remarks with a brief description of the system in Zurich, Switzerland. 700 w. Elec Eng, N Y—Oct. 7, 1897. Serial. 1st part. No. 15753.

High Speed.

A High-Speed Road—The Lorain and Cleveland Electric Railway. E. P. Roberts. Illustrated detailed description of a completely equipped and thoroughly constructed American line. 2700 w. Elec Eng, N Y—Oct. 14, 1897. No. 16044.

Minneapolis.

The Construction of Street Railway Tracks in Minneapolis and St. Paul, Minnesota. F. W. Cappelen. Paper presented at the Chicago meeting of the American Society of Municipal Improvements, with views. A very full account of this work. 2500 w. Eng News—Oct. 14, 1897. No. 15971.

Motive Power.

Electricity as a Motive Power for the Suburban-Railway Service of New England. Sidney H. Short. Considers the suburban service about Boston as representative of that of all the territory under discussion. Shows the operating expenses to be largely in favor of electricity. 3500 w. St Ry Jour—Oct., 1897. No. 16010 D.

The Battle of the Motive Powers. Editorial presenting a brief résumé of the relative advantages and disadvantages of different forms of motive power so far as developed in actual practice up to the present time. 4000 w. St Ry Jour—Oct. 1897. No. 16006 D.

Power Distribution and the Use of Multiphase-Current Transmission for Ordinary Street Railways. Maurice Hoopes. Read at the Convention of the American Street Railway Assn. The paper considers the comparative merits of systems to meet the demands of changed conditions brought about by extensions of roads and other causes. 7000 w. Elec Wld—Oct. 23, 1897. No. 16163.

Motors.

Railway-Motor Design. Alfred E. Wiener. States the conditions desirable in a railway motor, considering each separately. Also gives calculations connected with railway motor design. 2500 w. Am Elect'n—Oct., 1897. No. 15972.

Motor Testing.

Some Methods of Making Efficiency Tests of Street-Railway Motors. Frank B. Porter. Describes a simple method of efficiency test which will give good results when applied to the street-railway motor in the repair shop. Ill. 1800 w. St Ry Rev—Oct. 15, 1897. No. 15988 C.

Municipal Ownership.

A Matter of Municipal Ownership, and What Came of It. F. M. Explains the position of the city of New York in its relation to the Sixth and Eighth Avenue systems. 2000 w. Harper's Wk—Oct. 30, 1897. No. 16172.

Municipal Ownership.

Municipal Ownership and the Operation of Street Railways. P. F. Sullivan. Abstract of a paper read before the convention of the American Street Railway Assn. Unfavorable to municipal ownership in American cities. 800 w. Elec Wld—Oct. 23, 1897. No. 16166.

Niagara Falls.

Street Railways of Niagara. Brief illustrated descriptions of the various electric lines on both sides the river, covering 127 miles of track. 4400 w. St Ry Rev—Oct. 15, 1897. No. 15983 C.

The Electric Railways of the Niagara River Region. A brief review of the conditions which have affected the industrial growth of this region, the street railway development, and other things of interest. Ill. 11500 w. St Ry Jour—Oct., 1897. No. 16004 D.

One Rail.

A One-Rail System of Light Railway. Fred. J. Rowan. Abstract of a paper read before the Federated Inst. of Mining Engs. Presents the advantages of the system under consideration. 1600 w. Col Guard—Sept. 24, 1897. No. 15699 A.

Portable Railways.

Portable Electric Railways. Extracts from paper by F. Zezula, in the *Zeitschrift für Kleinbahnen*, discussing the value of light portable railways, with especial reference to military operations; and also from a paper by Dr. Werther, read before the German Brick Mfrs. Assn. on the use of electricity as a motive power on portable railways in brick works, &c. Ill. 1500 w. Brick—Oct., 1897. No. 15780.

Power Station.

The New 70,000 H. P. Central Power-Station of the Metropolitan Street Railway Company, New York. Brief illustrated description of the proposed structure. 1100 w. Elec Eng, N Y—Oct. 7, 1897. No. 15752.

Public Operation.

Public and Private Operation of Street Railways. I. Should Greater New York Operate Its Street Railways? Yes. John Dewitt Warner. II. Municipal and Private Ownership of Street Railways—A Study of Results and Possi-

bilities. Edward E. Higgins, Two papers discussing the pros and cons of this subject. Munic Af—Sept., 1897. No. 15953 C.

Rapid Transit.

The Enormous Possibilities of Rapid Electric Travel. Charles Henry Davis and F. Stuart Williamson. With full detailed estimate of cost for the construction of a three-track electric railway between New York and Philadelphia capable of making the run in 36 minutes. Figures are given showing the probable expenses, receipts and profits. 4500 w. Engineering Magazine—Nov., 1897. No. 15592 B.

Storage Battery.

Application of the Storage Battery to Electric Traction. Charles Hewett. Extracts from a paper read at the American Street Railway Assn. Reviews the most important applications of the storage battery to electric traction. 2800 w. Elec Wld—Oct. 23, 1897. No. 16164.

Surface Contact.

Surface-Contact Street-Railway System. Illustrated description of experiments carried on at Schenectady, N. Y.,upon a stretch of track forming a part of the tramway system of the General Electric Co.'s Works. 1600 w, Ir Age—Oct. 21, 1897. No. 16074.

Suburban.

Electric Traction for the Pennsylvania Railroad Company's Suburban Service near Philadelphia. Charles T. Child. Discusses the engineering side of the problem of adopting electric means for this suburban system. Ill. 3500 w. Elec Wld—Oct. 16, 1897. No. 16049.

Switzerland.

The Orbe and Chavornay Electric Railway. C. S. DuRiche Preller. Describes the line, power, rolling stock, electrical equipment, service, &c., giving net results of this road. 1600 w. Engng—Oct. 1, 1897. No. 15913 A.

Test Car.

New Electrical Features on the Lindell Railway, St. Louis. Describes a car for testing and maintaining bonding and other uses, designed by Samuel Barnes. 1000 w. St Ry Rev—Oct. 15, 1897. No. 15987 C.

Track Bonding.

Track Bonding—How Can We Obtain the Best Results? H. C. Newton. Discussion of the subject with the conclusion that the really practical process is to solder the bond to the rail. 1200 w. Elec, N. Y.—Sept. 29. 1897. No. 15672.

Tracks.

Girder Rails for English Street-Railway Tracks. Illustrated description of rail, with the reasons for using this type as given by Joseph Kincaid, the engineer. 800 w. Eng News—Oct. 14, 1897. No. 15969.

Track Renewal.

Track Renewal on the Olive Street Cable Road, St. Louis. An account of this work, which consists of laying 60-ft. rails with welded joints. 1000 w. R R Gaz—Oct. 22, 1897. No. 16093.

Trucks.

Peckham's Swivel-Trucks for High-Speed Electric Service. Illustrated description of trucks designed for high speeds and heavy loads. 800 w. R R Gaz—Oct. 15, 1897. No. 15963.

Vienna.

The Rolling Stock of the Vienna City Railway. (Die Fahrbetriebsmittel der Wiener Stadtbahn.) Describing and illustrating the locomotives and cars for the new local railway in the city of Vienna. Two articles. 1 plate. 7500 w. Zeitschr d Oesterr Ing u Arch Ver—September 17 and 24, 1897. No. 15829 E.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

The Q. & C. Company, Chicago, Ill., and New York.=Illustrated catalogue of cold-sawing machines, for hand and power operation in various situations and on various classes of work. Contains, also, matter descriptive of sawing-machine grinders and their use.

Frank Kneeland Machine Co., Pittsburg, Pa., U. S. A.=Handsomely illustrated catalogue of rolling-mill machinery, roll-turning lathes, shears of various types, roll-trams, cold-rolling, structural and bar mills, blooming mills, hydraulic cranes, etc. The half-tone engravings, which are excellent, are accompanied by very brief descriptive text.

The Stirling Metal Co., Stirling, New Jersey, U. S. A.=Small circular describing the Stirling anti-friction metal, Babbitt metal, and white brass.

Stedman's foundry and machine works, Aurora, Ind., U. S. A.=(*a*) illustrated descriptive catalogue of crushing, grinding, pulverizing, mixing, and screening machinery, devoted chiefly to Stedman's disintegrator for ores, rock, clay, fertilizers, and other materials. Engravings and sectional drawings show the machinery in various sizes, with data of weight, capacity, power, and price; (*b*) special catalogue of the machinery as adapted to handling clay, shale, and slate for paving-brick, pottery, tiling, etc.; (*c*) pamphlet illustrating and describing coal-breaking, coke-crushing, and pulverizing machinery; (*d*) special circular of machinery adapted to grinding and screening lime, gypsum, soap-powder, white lead, and similar materials.

Landis Tool Co., Waynesboro, Pa., U. S. A.=Illustrated descriptive catalogue of universal and plain grinding machines for cylindrical, conical, and plane-face surfaces. The photo engraving of each machine is accompanied by general data of capacity, power, speed, weight, accessories, etc., —and complete general description and list of sizes is appended.

Harrison Safety Boiler Works, Phila., Pa., U. S. A.=Leaflet of the "Cochrane Special Feed-Water Heater and Receiver," with diagram showing the pipe connections.

Geo. F. Molter & Sons, York, Pa., U. S. A.=Leaflet with illustration and table of principal dimensions of the "Molter" portable engines.

Queen City Supply Co., Cincinnati, Ohio., U. S. A.=Small illustrated catalogue of vises of sundry patterns and for various trades.

Robins Conveying Belt Co., New York City.=Illustrated catalogue of belt conveyors, picturing and describing the adaptation and application of the troughed-belt to the conveying of many classes of material, and to the reception and discharge of the material at intermediate points along the length of the conveyor. The mechanical and operative advantages of the system are concisely stated.

Ernest M. Bowden, Earls' Court, London.=Leaflet illustrating and describing a new mechanical movement for transmission of power along slack wires.

Keystone Electric Co., Erie, Pa., U. S. A.=Illustrated descriptive bulletin of direct-current multipolar generators and motors for light and power. The engravings and text are very handsomely printed. Elaborate, but very clear, tables give all data of slow- and medium-speed motors and generators, and diagrams exhibit assembly and foundation, connections, arrangement of belted units, and switchboard connections.

Gas Engine & Power Co., and Charles L. Seabury & Co. (consolidated), Morris Heights, New York City.=Illustrated catalogue of steam and sail yachts, naphtha launches, marine engines, and boilers. The half-tone engravings are unusually good, and represent typical craft built at the company's works. Descriptive text accompanies each.

The Philadelphia Museums, Phila., Pa., U. S. A.=Circular of the Laboratory of Tests and Technology, giving instruction for submitting samples, general information, and schedule of official fees.

University of California, Berkeley, Cal., U.S.A.=Prospectus of the "Phebe Hearst Architectural Plan," an architectural competition for the design of the magnificent new buildings which it is proposed to erect.

The Westinghouse Machine Company, Pittsburg, Pa.=Illustrated descriptive catalogue of Westinghouse gas-engines, setting forth their applications and advantages.

Joseph Dixon Crucible Company, Jersey City, N. J., U. S. A.=Pamphlet, entitled "The Merits of Lead Paints and Dixon's Silica-Graphite Paint Compared."

The Link-Belt Machinery Co., Chicago, Ill., U. S. A.=Illustrated catalogue on heavy paper, devoted to machinery and methods for preparing coal by means of shaking-screens and picking-tables, and to the Luhrig system of washing and classifying coals.

Consolidated Gas Company of New York="The Comfort of Heating by Gas," an illustrated pamphlet, in two colors, devoted to the application of gas-firing to domestic purposes and the use of gas as fuel in all departments of the household. The matter is purely descriptive and suggestive, and gives no exact data.

R. Universita Romana Scuola d' Applicazione per gl' Ingegneri=Annual catalogue, for the scholastic year 1897–98, of the engineering school of the Royal University, Rome. Contains extract from the charter of the University, rules of the school and the library, list of the faculty, calendar, scheme of studies, and list of graduates.